EXAMINING AND GRADING GRAINS

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EXAMINING AND GRADING GRAINS

BY

T. LYTTLETON LYON, PH.D.

PROFESSOR OF AGRONOMY, UNIVERSITY OF NEBRASKA

AND

E. G. MONTGOMERY, B.Sc.

ADJUNCT PROFESSOR OF AGRONOMY, UNIVERSITY OF NEBRASKA

GINN & COMPANY

BOSTON · NEW YORK · CHICAGO · LONDON

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The Athenæum Press
GINN & COMPANY · PRO-
PRIETORS · BOSTON · U.S.A.

PREFACE

Two years ago we published for the convenience of our students the exercises used in our field-crop laboratory. These exercises seemed to meet the needs of other teachers, and during the past year a number of the agricultural colleges and a few normal schools have used the publication.

No laboratory manual in field crops having been published previous to this time, and comparatively little having been done towards developing a systematic laboratory course in this subject, it was thought that a course might be worked out that would be of at least temporary usefulness, and would make for uniformity in laboratory instruction, by getting the opinions and, as far as practicable, the methods of those giving such instruction, and incorporating these in a new edition of "Examining and Grading Grains." This has been done, and we wish to express our thanks for counsel and material contributed by Professor Alfred Atkinson, Professor C. P. Bull, Professor F. C. Burtis, Professor G. A. Crosthwait, Professor James A. Foord, Professor A. N. Hume, Professor Thomas F. Hunt, Professor F. S. Johnston, Professor A. G. McCall, Professor M. F. Miller, Professor W. H. Olin, Professor George Severance, Professor V. M. Shoesmith, Professor A. L. Stone, Professor A. M. Ten Eyck, Professor A. T. Wiancko.

The exercises are planned to cover about one year's laboratory work of four hours per week. The work is intended

for agricultural colleges and well-equipped normal or high schools. Most of the exercises are easily modified to suit local conditions or the equipment of the school.

It has not seemed best to discuss in the text methods of teaching the subject. We have, instead, prepared a pamphlet giving suggestions for collecting material and conducting the work. This can be secured from the publishers.

THE AUTHORS

LINCOLN, NEBRASKA

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EXAMINING AND GRADING GRAINS

SECTION I — WHEAT

CLASSIFICATION OF SPECIES AND VARIETIES

Wheat belongs to the family of plants known as the *Gramineæ*, which includes all of our cereal crops and meadow grasses. It is classified into several species and varieties, founded on distinct differences.

All of the *Gramineæ* are readily distinguished by having only one seed leaf and are technically known as monocotyledons.

Wheats seem to be most properly classified into species and races as follows:

Triticum monococcum (1-grained wheat): spikes compact, spikelets 3-flowered but 1-grained, bearded; very old, belongs to Stone Age; grown in Spain, Germany, Switzerland; not much of a bread wheat.

Triticum Polonicum (Polish wheat): large, open heads, spikelets 2-to-3-seeded, bearded; seeds long, bright, and glossy; cultivated in parts of eastern Europe and northern Africa.

Triticum sativum, divided into races as follows:

Tr. sat. vulgare (common wheat): 4-flowered spikelets, 3-grained, both bearded and beardless; our common

bread wheats, many varieties, almost exclusively grown in this country.

Tr. sat. compactum ("Hedgehog wheat," "Dwarf wheat"): spikes short, dense, distinctly 4-sided, both bearded and beardless; grown in Switzerland and neighboring region, also in Turkestan and Chile.

Tr. sat. turgidum ("English wheat," "Egyptian wheat"): spikes large, dense, 4-sided, 2-to-3-seeded, bearded; largely grown in Mediterranean countries, also in Egypt, England, and Germany.

Tr. sat. durum (true bearded, or hard wheats): spikelets 3-to-4-seeded, long, stiff awns; seeds large, bright, and glossy. This race comprises the so-called "macaroni" wheats, which are at present being extensively tested in the semi-arid portions of the country. They are widely grown in eastern Europe and northern Africa.

Tr. sat. Spelta (spelt): spikes long and very loose, darkish colored when ripe, spikelets 3-seeded at base, 2 at top of spike; chaff adheres to grain; little grown in this country; at home in the mountain regions of Europe and Asia.

Tr. sat. dicoccum (Emmer): spikelets 2-seeded, rather compactly arranged in 2 rows, generally dark colored, grain very hard, inclosed in chaff; little grown in this country; more common in central Europe.

The varieties of *Triticum durum*, commonly known as "macaroni wheats" because of the excellent quality for the manufacture of macaroni and similar pastes, are considered strongly drought-resistant and give promise of becoming valuable wheats for the semi-arid regions of this country.

Emmer (*T. dicoccum*), commonly confused with spelt, also gives promise of a wide usefulness. Of these wheats we are principally concerned with the varieties of *Triticum sativum vulgare*.

LABORATORY STUDY OF CHARACTERS

Let the teacher provide each student with specimens of the

FIG. 1. On the left is shown a whole wheat spike. On the right the structure of a spikelet is illustrated and the various parts named

types included in the above classification, and try to identify the specimens by use of the descriptions given. After this

the student should proceed to study these wheats, and as many specimens of native wheats as he can obtain, according to the following method.¹

Drawings. Make a drawing from a spike of each of the types as follows :

First, the spike as a whole ; then, removing a spikelet, draw this entire, showing the imbricated view. Then dissect the spikelet, drawing each part out separately, being careful to arrange the parts in their proper relative position.

The method of cross fertilizing wheats may now be easily explained.

The wheat spike and descriptive terms. The following is a list of descriptive terms which apply to the wheat spike. The student is supplied with two or three spikes of the wheat to be described, and proceeds to fill out the blank used in describing wheats, using the list of descriptive terms as a reference.

TERMS FOR DESCRIBING WHEAT

Spike

1. { Beardless (Fig. 2. *B*).
Partly bearded (Fig. 2. *C*).
Bearded (Fig. 2. *A*).

2. Length, inches.

3. { Very open (Fig. 2. *B*).
Open.
Medium (Fig. 1. *A*).
Compact (Fig. 2. *A*).
Crowded (Fig. 2. *C*. *tip*). } Refers to how closely the spikelets are set together.

¹ All specimens of grain in head will be in better condition for study if placed in a moist chamber, or between pieces of moist paper for a few hours, in order to toughen the parts.

Shape

1. { Tapering toward apex. Heads which taper gradually from the middle toward the tip.
 Tapering both ways. Heads which are spindle shaped or largest in middle.
 Uniform (Fig. 2, *A*). Heads same diameter throughout.
 Clubbed (Fig. 2, *C*).
 Heads larger at tip than below.

2. { Square. Refers to cross section.
 Flattened with spikelets (Fig. 1, *A*).
 Diameter of head through spikelets least.
 Flattened across spikelets (Fig. 2, *A*).
 Diameter through spikelets greatest.

3. { Sterile spikelets, 1, 2, 3, 4.
 Sterile spikelets at tip and base of spike.

Color

1. { Whitish.
 Yellow.
 Yellowish brown.
 Rosy.
 Red.
 Bluish.
 Brown.
 Black.

FIG. 2. Three types of wheat heads: *A*, macaroni wheat; *B*, a common form of awnless winter wheat; *C*, club wheat

Awns

1. { Long, 4 in. or more in length.
Medium, 2 in. to 4 in. in length.
Short, 2 in. or less in length.
2. { Parallel (Fig. 2, *A*).
Spreading.
Spreading widely (Fig. 1, *A*). } Has reference to the relative position of awns and spike.
3. { Deciduous. Awns falling as soon as grain is mature.
Partly deciduous.
Persistent. Awns not falling off naturally.

Spikelet

1. { Spreading widely (Fig. 3, *B*).
Spreading.
Narrow (Fig. 3, *A*). } Refers to the relative width of the spikelet.
2. Number of grains, 1, 2, 3, 4, 5, 6, 7.

Outer glume

1. { Hairy (Fig. 4, *B* and *C*).
Partly hairy.
Smooth (Fig. 4, *A* and *D*).

FIG. 3. Two types of wheat spikelets FIG. 4. Types of outer glumes

Grain

1. $\left\{ \begin{array}{l} \text{Very hard.} \\ \text{Hard.} \\ \text{Medium.} \\ \text{Soft.} \\ \text{Very soft.} \end{array} \right\}$ This point is determined by biting or cutting open several grains and comparing with standard samples.

Size

Weight of 100 average seeds in grams.

Color

1. $\left\{ \begin{array}{l} \text{Whitish.} \\ \text{Yellowish.} \\ \text{Clear amber.} \\ \text{Dull amber.} \\ \text{Clear red.} \\ \text{Dull red.} \end{array} \right\}$

Cross section

1. $\left\{ \begin{array}{l} \text{Very horny.} \\ \text{Horny.} \\ \text{Dull.} \\ \text{Starchy.} \end{array} \right\}$ Refers to appearance. When the grain in cross section is hard and vitreous in texture it is "very horny," but when there is no horny portion, but the cross section is all white and starchy in appearance, it is called "starchy."

General characters

1. $\left\{ \begin{array}{l} \text{Hardy.} \\ \text{Delicate.} \end{array} \right\}$
 2. $\left\{ \begin{array}{l} \text{Early.} \\ \text{Medium.} \\ \text{Late.} \end{array} \right\}$
 3. Days maturing.
 4. $\left\{ \begin{array}{l} \text{Autumn-planted.} \\ \text{Spring-planted.} \end{array} \right\}$
- These points can only be determined by referring to field notes on the variety.

OUTLINE FOR DESCRIBING WHEAT

	SAMPLE No. 1	SAMPLE No. 2	SAMPLE No. 3	SAMPLE No. 4	SAMPLE No. 5
Spike					
1					
2					
3					
Shape					
1					
2					
3					
Color					
1					
Awns					
1					
2					
3					
Spikelet					
1					
2					
Outer Glume					
1					
Grain					
1					
Size					
Color					
1					
Cross section					
1					
General characters					
1					
2					
3					
4					

Student's Name..... Date.....

EXAMINING THE QUALITY OF WHEAT

Each student should be provided with about ten samples of wheats. These should represent as great a variety of qualities as possible.

The first five samples might be arranged according to the degree of hardness, and the following arrangement is suggested: No. 1, Macaroni Wheat; No. 2, Hard Winter; No. 3, Northwestern Spring; No. 4, Red Winter; No. 5, White Winter. The rest of the samples may all be of one type, as Hard Winter, or Red Winter, but should represent several different grades.

Report Card

WHEAT

No.	Variety	
Weight per bushel		lbs.
Color	Whitish	
	Yellowish	per cent
	Clear amber	
	Dull amber	per cent
	Clear red	
	Dull red	per cent
Unsound grain		per cent
Foreign matter		per cent
Hardness and texture	Hard and vitreous	per cent
	Intermediate	per cent
	Soft and starchy	per cent
Weight of 100 grains		grams
Size of grain	Large	per cent
	Medium	per cent
	Small	per cent
Viability		per cent

[Form No. 1]

Let the student now carefully compare the first five samples as to hardness, texture, color, size of berries, etc. This is most easily accomplished by filling out a blank card for each sample, similar to Form No. 1 on page 9. This gives a qualitative analysis of each sample and necessitates a critical study. He should understand clearly the correlations between hardness, texture, and color; how these are affected by climate, soil, and moisture; in what way they affect the bread-making qualities of the wheat; and in what regions the different types are principally grown. In the judging and grading work which follows, these five samples should be used as standards in hardness, texture, and color.

The following notes of general information should be carefully read by the student.

Notes on the Quality of Wheat

Hardness. The hardness of wheat varies greatly in different sections of the country. This is due to the definite effect of environment. Wheats grown in a region of abundant rainfall and under humid conditions, or under irrigation, are usually softer and lighter colored and lower in protein content than wheats grown under dryer conditions.

Winter wheats grown in most of the states east of the Mississippi River are of the softer type and are known as "red" winter wheats, while those grown in the belt of country bordering on the semi-arid and running through Nebraska, Kansas, and Oklahoma, are generally of the hard, dark red type, and are known as "hard" winter wheats.

The hard winter wheats are mostly of the Turkish Red variety. The characteristics, however, which mark it as a

FIG. 5. Structure of the wheat berry: *A*, wheat berry cut through at the crease; *B*, cross section of the wheat berry; *C*, bran scale. Ordinarily a few starch-bearing cells adhere to the inside of the bran

hard winter wheat are due to environment, since this same variety, if grown in Illinois for example, soon loses its hard qualities and grades instead as a "red" winter wheat.

The same is also true of spring wheats, the famous "No. 1 Hard Spring" coming from the somewhat dry climate of the Dakotas, Minnesota, and the Northwest.

Northern wheats may be harder or softer than southern, though this quality seems to depend on soil and moisture more than on latitude.

Texture. Texture and hardness are closely correlated. The texture is examined by making cross sections of the grain and is described as horny when it is found to be dark and vitreous in appearance, with no starch showing. Opposed to these are the grains which are white and starchy throughout. This is the characteristic appearance of the soft white wheats of the Pacific coast and Australia, while the horny texture is characteristic of the macaroni, all hard winter and spring wheats. Wheats of a horny texture are generally higher in protein content and produce a stronger flour.

Weight. The weight per measured bushel has always been regarded as of the greatest importance in judging the quality of wheat. In a general way it is true that a good wheat never has a low weight per bushel, while a poor wheat is never high in weight.

Light weight may be due to immaturity, to premature dry weather or hot winds, or to the attacks of insects. The skin is wrinkled and not well filled out with starch. The weight of good wheat may be reduced by exposure to inclement weather, when part of the grain is sprouted or is swelled and soaked by water until it never quite regains its normal size; or by overheating in the stack, called stack

burning; or by piling up in bins when too damp, causing heat and mold.

Soundness. A good No. 1 wheat should have no sprouted, decayed, or injured grains from any cause, as exposure, stack burning, or moths. A No. 2 wheat might have a few discolored grains, but none sprouted. A No. 3 wheat, if dry and in good condition otherwise, might contain a few sprouted grains. However, the number of injured grains which may pass in a grade depends largely on how good the wheat was before suffering injury, the present dryness, etc., of the sample. Grading is always based as nearly as possible on the actual milling quality of the grain.

Mustiness. This is caused usually by dampness, either while the grain is in stack or bin. Musty wheat is almost worthless for flour, since the grain is permeated with a musty flavor. For this reason even a slight trace of mustiness is always discriminated against, even though the wheat may still be used for low-grade flour. Musty grain is often worked into chop or some form of stock food.

Color. Wheat ranges in color from nearly a brick red, through various shades of brown, to almost white. In a general way wheats from humid climates are light colored, while those of dry climates are dark. Some have a smooth, bright appearance, while in others the color is dull. Good wheat should not be bleached or in any way discolored, but should be generally bright, and in the hard wheats should have a vitreous appearance. The occurrence of "yellow berries" in hard wheats greatly depreciates their value, as they give a yellow color to the flour.

Stack burning gives wheat a dark and somewhat burnt appearance, exposure to weather produces a bleached and

dull appearance, while overheating in the bin usually gives a whitish appearance and musty smell. Overheating in stack or bin often gives the germ end a dark color.

JUDGING WHEAT

For the judging work first use the ten samples provided in the previous exercise. When these have been scored let the instructor go over them carefully with the students, after which the class should have access to a good general collection of wheat samples. If possible the samples should be provided in peck or half-bushel lots.

Score Card for Wheat

Variety Name Number of Exhibit

	CREDIT	1	2	3	4	5
Milling quality, 50%						
(flour making) .						
Weight	25					
Soundness and dirt .	25					
Uniformity, 50%						
Hardness and texture	30					
Color	20					
Total	100					

Student's Name Date

Explanation of Score Card

In this score card wheat is judged entirely from the miller's standpoint. If the wheat were being selected for seed, slightly different points might be considered, and the emphasis laid

upon the above points in a different manner; but since so little is known as to just what constitutes a good seed wheat, outside of the miller's demands, and since the only important point, that of vitality, requires so much time to determine, it is thought best to judge the wheat from the miller's standpoint only.

Weight. Wheat should weigh sixty pounds per bushel. Cut two points for every pound below this. Other things being equal, a light wheat always contains a higher per cent of bran than heavy, and a lower per cent of patent flour.

Soundness and dirt. Sprouted, cracked, or unsound berries are worthless for flour, and must either be separated out before grinding or the wheat used only for making medium or low-grade flours. Such grains are of little more value than weed seeds. Cut two points for every per cent of weed seeds and unsound grains.

Uniformity in hardness and texture. Take about a one-ounce sample and divide it into three parts, — (1) berries hard and vitreous, (2) berries soft and starchy, (3) berries intermediate. Let the class having the highest per cent in numbers or weight determine the classification of the sample. Cut one point for each per cent representing the other extreme, and one point for each two per cent of intermediate. (If the largest class is intermediate, then regard the other two classes as extremes.) In case of a fairly uniform sample it is often best to divide them into only two portions, cutting one point for each two per cent off.

Uniformity in color. In case of a mixture of colors cut two points for each per cent off color. (Yellow berries in hard winter wheat should be regarded as off color.)

FIG. 6. Structure of the wheat berry (after Cobb): *A*, section nearly to center of grain; *B*, cellular tissue of starch-bearing cell; *C*, Talavera de Bellevue, percentage area in cellular tissue, 29.8%; *D*, Belotourka, percentage area in cellular tissue, 18.2%.

DETERMINING THE GLUTEN CONTENT OF WHEAT

The student should be provided with flour made from each of these five types of wheats, for the gluten test.

Weigh out thirty grams of flour made from a hard winter or spring wheat, and mix with enough water to form a stiff dough. After it has been worked into this condition allow it to stand for half an hour. Transfer the dough to a cloth and let a gentle stream of water run over it, working it meanwhile with the fingers. Continue the washing until no more starch is washed out, which is shown by the water being clear when it runs away from the dough as it is being worked in the cloth or in the hand. Allow to remain in water.

Perform the same operation with a very soft wheat, as for instance, Sonora wheat from the Pacific coast. Compare the amounts of gluten from the two wheats.

COMMERCIAL GRADING OF WHEAT

The student should use the same set of samples for the commercial grading work that he has used in judging, since he already has some knowledge of the relative merits of these wheats. At least a part of the samples should be officially graded.

The object of this work is not primarily to learn what constitutes a grade, but rather to give the student a knowledge, based upon critical examination, of the qualities and characteristics of the common varieties and grades of wheat, both good and bad.

*Wheat Inspection Rules*¹

No. 1 Red Winter Wheat shall be pure Red Winter Wheat of both light and dark colors of the shorter-berried varieties, sound, plump, and well cleaned.

No. 2 Red Winter Wheat shall be Red Winter Wheat of both light and dark colors, sound and reasonably clean.

No. 3 Red Winter Wheat shall include Red Winter Wheat not clean and plump enough for No. 2, but weighing not less than fifty-four pounds to the measured bushel.

No. 4 Red Winter Wheat shall include Red Winter Wheat damp, musty, or from any cause so badly damaged as to render it unfit for No. 3.

Red Winter Wheat containing a mixture not exceeding five per cent of White Winter Wheat shall be classed as Red Winter Wheat.

Red Winter Wheat containing more than five per cent of White Winter Wheat shall be graded according to the quality thereof and classed as White Winter Wheat.

Hard Winter Wheat. The grades of Nos. 1, 2, 3, and 4 Hard Winter Wheat shall correspond in all respects with the grades of Nos. 1, 2, 3, and 4 Red Winter Wheat, except that they shall be of the Turkish variety.

In case of mixture of Turkish Red Winter Wheat with Red Winter Wheat, it shall be graded according to the quality thereof and classed as Hard Winter Wheat.

No. 1 Northern Spring Wheat must be Northern-grown Spring Wheat, sound and reasonably clean and of good milling

¹ Rules adopted by the Board of Railroad and Warehouse Commissioners for the inspection of grain at Chicago.

quality, and must contain not less than 50 per cent of the hard varieties of Spring Wheat.

No. 2 Northern Spring Wheat must be Northern-grown Spring Wheat, not clean enough or sound enough for No. 1, and must contain not less than 50 per cent of the hard varieties of Spring Wheat.

No. 1 Spring Wheat shall be sound, plump, and well cleaned.

No. 2 Spring Wheat shall be sound, reasonably clean, and of good milling quality.

No. 3 Spring Wheat shall include all inferior, shrunken, or dirty Spring Wheat, weighing not less than fifty-three pounds to the measured bushel.

No. 4 Spring Wheat shall include Spring Wheat, damp, musty, sprouted, badly bleached, or for any cause which renders it unfit for No. 3.

White Spring Wheat. The grades of Nos. 1, 2, 3, and 4 White Spring Wheat shall correspond with the grades of Nos. 1, 2, 3, and 4 Spring Wheat, except that they shall be of the White variety, or shall contain 5 per cent or more of such White Wheat.

Frosted Wheat shall in no case be graded higher than No. 4, except that the grade of No. 3 may contain as much of said Frosted Wheat as it is customary to allow of wheat damaged in any other way.

Mixed Wheat. The grades of Nos. 2 and 3 Mixed Wheat shall be equal in quality to the grades of Nos. 2 and 3 Red Winter Wheat, except that they shall include mixtures of Spring and Winter Wheat.

In examining a sample of wheat it is well to take up each point, one at a time at first, as "hardness" or "texture," and

examine the sample for this. Make a note of your observation in each case. After the sample has been carefully examined in this way make out a brief report on each sample, something after the following plan:

NO. SAMPLE	GRADE	WEIGHT PER BUSHEL	REMARKS
1	{ 2 Hard Winter }	{ 58 lb. }	{ Horny texture, few yellow berries. }
2	{ 3 Red Winter }	{ 56 lb. }	{ Many bleached kernels, lacks plumpness, slightly musty. }

TESTING WHEAT FOR PURITY

Standard for purity 99 per cent.

Take about a half-pint sample and spread on a table, carefully separating all impurities, as weed seeds, straws, etc. Then find by weight the amount of pure seed and foreign matter, and calculate per cent of purity.

Examine the foreign matter carefully and identify the varieties of weed seeds found.

TESTING WHEAT FOR VIABILITY

Standard for germination 95-98 per cent.

If taking the sample from a bin, do not take it from one spot, but thoroughly mix several shovelfuls, and then take out a small sample and take from this at random 100 grains. Place in moist chamber, as described on page 94, and moisten daily. Keep as near as possible at a temperature ranging from 80° to 90°F. Germination should begin in three days and be complete in about six.

When the radicle has reached a length of one fourth inch or more the germination is sufficient. Remove the sprouted grains daily until germination has ceased, then by counting the number of grains left and subtracting this number from 100 you have the per cent of germination.

STUDY OF VARIATION IN WHEAT PLANTS

This exercise is valuable to illustrate the natural variation found in all kinds of plants, and also in showing the value of the "individual plant method" of selection for pure seed or improved strains.

The plants are grown by planting one seed in a place, six inches apart each way. When the plants are mature they are pulled up and laid away. The class should work over as large a number of plants as possible, but not less than 100. The following data should be obtained for each plant:

1. Number of spikes per plant.
2. Average length of spikes per plant.
3. Average number of berries per spike.
4. Number of berries per plant.
5. Weight of berries per plant.
6. Average weight of berries per spike.
7. Weight of 100 berries.
8. Average weight of berry per plant.

A convenient form for recording the properties of 100 plants may be found in the table on the following page.

After all plants have been examined the following general correlations should be worked out:

1. Correlation between number of spikes per plant and average length.

2. Correlation between number of spikes per plant and average weight of grain per spike.

3. Correlation between number of spikes per plant and total yield of grain.

4. Correlation between total yield of grain and size of berry.

This is most easily carried out by arranging the plants according to the characteristics for which a correlation is wanted. For example, arrange the wheat plants according to number of spikes per plant, or according to yield per plant. After such an arrangement the correlations may be made still more graphic by plating the curves on coördinate paper.

PLANT NUMBER	NUMBER OF SPIKES PER PLANT	AVERAGE LENGTH OF SPIKES PER PLANT	AVERAGE NUMBER OF BERRIES PER SPIKE	NUMBER OF BERRIES PER PLANT	WEIGHT OF BERRIES PER PLANT	AVERAGE WEIGHT OF BERRIES PER SPIKE	WEIGHT OF 100 BERRIES	AVERAGE WEIGHT OF BERRY PER PLANT
1								
2								
3								
4								
5								
6								

BLUESTONE OR COPPER-SULPHATE TREATMENT FOR STINKING SMUT OF WHEAT

(Prepared by A. N. Hume, University of Illinois)

Immerse the seed for ten minutes in a solution of copper sulphate at the rate of one pound to five gallons of water. Allow it to stand for ten minutes in a bag or basket to

FIG. 7. Natural variation found in wheat plants grown under uniform condition. These two plants were taken from a bed where the plants were planted one in a place, 6 inches apart each way

drain, and then spread and dry. Or the seed may be sprinkled at the rate of one gallon of the solution to four bushels of grain, sprinkling and stirring until thoroughly wet. At the end of an hour dry.

Treat a sufficient quantity of seed wheat by either one of the above methods.

Test duplicate samples of 100 kernels of treated and untreated seed and report as follows:

Treated Seed

Per cent germinated: (1) _____, (2) _____; Av. _____

Untreated Seed

Per cent germinated: (1) _____, (2) _____; Av. _____

Does the treatment injure the vitality of the seed?

Student's Name..... Date.....

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SECTION II — CORN

CLASSIFICATION OF SPECIES

The different groups of corn are classified as follows :

Order		<i>Gramineæ</i>
Genus		<i>Zea</i>
Species		<i>Mays</i>
Groups		

Zea tunicate (the pod corns): each kernel is inclosed in a pod or husk, and the ear inclosed in husks; rare; very leafy, hence called “cow corn.”

Z. erecta (the pop corns): characterized by the excessive proportion of corneous endosperm and the small size of the kernels and ear. Kernel is pointed-oval in form. The best popping varieties are corneous throughout. Popping is caused by the explosion of contained moisture on heating.

Z. indurata (the flint corns): characterized by starchy endosperm inclosed in corneous endosperm. They are oval in form. In some varieties the corneous portion is very thin at top and a slight indentation appears.

Z. indentata (the dent corns): characterized by corneous endosperm at the sides of the kernel, the starchy endosperm extending to the summit. By drying and shrinkage of the starchy matter the summit of the kernel is drawn in or together and indented in various forms. The kernel is long and wedge-shaped. Most extensively grown and has largest number of varieties.

Z. amylacea (the soft corns) : characterized by the absence of corneous endosperm ; all starchy ; no indentation ; shrinks uniformly ; shaped like flint but soft.

Z. saccharata (the sweet corns) : characterized by the translucent, horny appearance of the kernel, and the more or less wrinkled or shriveled condition ; shrinking due to change of starch to glucose ; wedge-shaped kernel.

Varieties of Corn

The so-called varieties of corn, like those of wheat, are very numerous.

Varieties of the dent type are most commonly grown in this country.

Flint corn ripens earlier and is adapted to the more northern latitudes.

Dent corn grows larger and yields heavier.

While there are numerous so-called varieties, there are only a few distinct and recognized breeds of uniform characteristics.

Owing to the ease with which varieties are produced, each locality generally has varieties peculiarly adapted to it.

LABORATORY STUDY OF SPECIES AND OF CHARACTERS

EXAMINATION OF SPECIES

Samples on the stalk of the various types of corn are provided.

For each of the six principal groups of corn carry out the following outline :

Describe a typical ear as to color, shape, indentation and depth of grain, length, etc.

Make drawings of both longitudinal and cross sections of grains, showing by appropriate shading where the germ, the starchy portion, and horny portions of the kernel are located.

TERMS FOR DESCRIBING CORN

The value of this exercise is to enable the instructor to fix the meaning of the technical terms used in describing an ear of corn. For example, the terms "deep indentation," or "wedge-shaped," may convey different meanings to different students. If the class all have a common understanding of these terms the regular work of corn judging is then much simplified.

Give each student an ear of corn and have him describe it by filling out the outline on page 32. Eight or ten ears should be described in this way.

FIG. 8. *A*, low-proteid corn kernel; *B*, high-proteid corn kernel

FIG. 9. Typical ears of corn: *A*, cylindrical ear; *B*, very tapering ear, rows dropping out; *C*, tapering ear, kernels becoming shorter toward the tip

Shape of Ear

- Cylindrical (Fig. 9, *A*).
- Tapering (Fig. 9, *C*).
- Very tapering (Fig. 9, *B*).

Length of Ear

- Long (over 10 inches).
- Medium (8 to 10 inches).
- Short (under 8 inches).

Circumference of Ear

- Large (over 8 inches).
- Medium (6 to 8 inches).
- Small (under 6 inches).

Color of Kernel

- Yellow.
- Variegated.
- White.
- Red.

FIG. 10. *A*, wedge-shaped kernel; *B*, round kernel; *C*, square kernel; *D*, edge view of kernels fitting close at tips; *E*, kernels with wide space at tip

Indentation of Kernel

- Smooth.
- Dimpled.
- Deeply dented.

Shape of Kernel

- Wedge (Fig. 10, *A*).
- Round (Fig. 10, *B*).
- Square (Fig. 10, *C*).
- Parallel-sided (Fig. 10, *D*).
- Pointed (Fig. 10, *E*).

Length of Kernel

- Long (Figs. 12, *A*, and 16, *B*).
- Medium.
- Short (Figs. 12, *B*, and 16, *A*).

Number of Rows of Kernels

- Many (20 or more).
- Medium (14 to 20).
- Few (under 14).

FIG. 11. A study of kernel types
(*Michigan Bulletin*, 34)

FIG. 12. Deep- and shallow-kerneled corn : *A*, long kernel, small cob ; *B*, short kernel, large cob

Space between Rows

(at crown of kernel)

Wide (Fig. 11).

Close (Fig. 11).

(at cob)

Close (Fig. 11).

Wide (Fig. 11).

Arrangement of Rows

Distinct. Paired.	}	In some corn the
		rows seem to be
		in pairs, while in
		others the rows are
		all separate.

Tips

Covered (Fig. 13, *F*).

Exposed (Fig. 13, *A*).

Swell of Butt

Deeply rounded (Fig. 13, *E*).

Moderately rounded.

Flat (Fig. 13, *D*).

Size of Butt

Enlarged (Fig. 9, *B*).

Uniform (Fig. 9, *A*).

Size of Shank

Small (Fig. 13, *C*).

Medium (Fig. 13, *E*).

Large (Fig. 13, *D*).

Size of Cob

Small (Fig. 12, *A*).

Medium.

Large (Fig. 12, *B*).

Color of Cob

Red. White.

For this exercise select ears or kernels that possess each of the characters mentioned under each head.

FIG. 13. *A* and *B*, poor tips, too much exposed; *C*, poor butt, shank too small; *D*, poor butt, shank and cob too large; *E*, ideal butt; *F*, ideal tip

OUTLINE FOR DESCRIBING CORN

Variety Name.....	Number of Sample.....
<i>Ear</i>	Arrangement.....
Shape.....	<i>Tip</i>
Length.....	
Circumference.....	<i>Butt</i>
<i>Kernel</i>	Swell.....
Color.....	Size.....
Indentation.....	<i>Shank</i>
Shape.....	Size.....
Length.....	<i>Cob</i>
<i>Rows</i>	Size.....
Number.....	Color.....
Space.....	
At ear.....	
At cob.....	
Student's Name.....	Date.....

COMPARATIVE STUDY OF CHARACTERS

The student should be provided with a ten-ear exhibit. Selecting some part, like the tip of the ear, first arrange the ears according to tips, placing the best tip at the right, then the next best tip, and so on, the poorest finally being on the extreme left.

The following order of study is suggested:

1. Place ears according to tips.
2. Place ears according to butts.
3. Place ears according to shape.
4. Place ears according to indentation.

5. Place ears according to shape of kernel.
6. Place ears according to space between rows.
7. Place ears according to market condition.
8. Place ears having both best butt and best tip.
9. Place ear first having best butt, tip, and shape, and so on down.

Continue the arrangements, adding one new part each time, until the student finally places the ears first, second, third, etc., when all parts are taken into consideration.

FIG. 14. A ten-ear exhibit of corn, and the box in which it is kept. The ears are placed from right to left, according to the quality of the butts. This illustrates the method of making a comparative study of some one character

JUDGING CORN

The operation of judging corn is an attempt to estimate numerically its value for seed. The principle involved is that an ear of corn when planted reproduces more or less closely its own characters in the resulting ears. By selecting for seed ears of uniform size, deep kernels, and other desirable characters, the production of nubbins, shallow kernels, and other objectionable characters is diminished, and the productiveness correspondingly increased.

Two types of score cards are shown, either of which may be used in judging. Each of these cards is typical of a system

FIG. 15. A case used in keeping the ten-ear exhibits of corn for judging

of judging adapted to the production of corn under certain conditions. The essential difference is that Score Card No. 1 is designed to discourage the production of a thick cob, chiefly because it retards drying of the grain in the fall, and thus makes the late-maturing corn likely to be injured by frost.

Score Card No. 2 is adapted to a region of light rainfall and dry atmosphere, where the grain dries out readily in

the fall, and where a thick cob is supposed to accompany drought resistance in the corn. Both cards favor a deep kernel.

Points to be Observed

Uniformity of Exhibit. The points that go to produce uniformity of exhibit are size, shape, and color of ear, appearance of tips and butts, and indentation of kernel. The ears should closely resemble each other in these characters; in other words, each ear should look as much as possible like every other ear. In considering this point the judge is not

called upon to decide as to the desirability of the characters possessed by the different ears, but solely as to their similarity.

The judge places the ten ears side by side on a table or bench with the butts towards him. He then, by removing one ear and replacing it by another, sorts over the exhibit until he has the similar ears lying side by side. If there are six similar ears of one type and four of another, he credits the exhibit with six similar ears, even should these not be so desirable as those of the other type.

Trueness to Type. Each variety of corn has, or should have, its character sufficiently constant and well marked to enable any one acquainted with the variety to recognize it. The combination of characters gives type to the variety. In judging trueness to type the ears possessing all of the variety characters to an unmistakable degree are credited with being true to type, while those failing in this respect are discarded.

Shape of Ears. Leaving the exhibit arranged as before, count the number of ears that are cylindrical or nearly so. Credit the exhibit with such ears only. A cylindrical ear is desirable because it permits the growth of kernels of uniform shape, and such ears generally have a larger proportion of corn to cob. A tapering ear must have kernels becoming smaller from butt to tip, or else must drop out one row or more between the butt and tip. In either case badly shaped and small kernels are produced.

Color of Cobs. The color of the cob is, to some extent, a guide to the purity of breeding of the exhibit. The presence of a white cob in an exhibit of otherwise red cobs is an indication that at some time there has been a cross with a white-cob variety. This may have occurred many years

before, and may not be a present detriment to the corn, but, on the other hand, it may be detrimental and for that reason is discountenanced. The same is true of the presence of a red cob in an exhibit of otherwise white ones. Some varieties of corn having white kernels have red cobs, but in such a case there should be no white cobs in the exhibit.

Color of Kernels. A yellow kernel on a white ear or a white kernel on a yellow ear shows that the corn has been fertilized by pollen from corn of another color; in other words, it shows that the variety is not strictly pure. The cross fertilization may have occurred in the year in which the ear was raised or it may be of earlier date; there is no way of distinguishing, but the fact is equally objectionable in either case.

Each kernel on the ear results from the fertilization of its ovary by pollen from the same plant or some other. The pollen is borne on the tassel. If any ovary is fertilized by pollen from corn of a different color, the resulting kernel will be of a different color from the rest of the ear.

A mixed kernel on a yellow ear may be readily seen, as the crown of the kernel is white. On a white ear the crown of a mixed kernel hardly shows the yellow color, but it may be seen on the part of the kernel beneath the crown. They are, therefore, harder to discover, and the judge must look very carefully.

Market Condition. The market condition of corn depends most largely upon its ripeness. Other conditions, such as freedom from smut or worms, and brightness of color, also enter into consideration to some extent. The degree of maturity is commonly determined by the firmness or looseness of the kernels on the cob, and by the stiffness of the

cob. Take in turn each ear in the hand and attempt to twist it. If the cob twists readily it is not well matured. If the cob is stiff, see if the kernels are loose on the cob. Looseness of the kernels indicates immaturity.

Tips of Ears. The tips of the cobs are very likely to protrude beyond the kernels. The extent to which this occurs will vary with the season and with the strain of corn. The tips are considered in selecting corn for seed because, being the last part of the ear to throw out silk, there is a possibility that the strain may acquire the habit of developing the tip silk too late to be fertilized, should ears without tip kernels be continually selected for seed.

On the other hand it is argued that, in the main, tips that are well filled out are found on ears of less than average length, and that their selection for seed must result in shortening the ear. However, where seed ears are required to be of a certain length, it is doubtful whether this argument will hold.

Butts of Ears. As the ideal ear is cylindrical in shape the butt should be uniform in diameter with the rest of the ear. It should be well rounded and symmetrical, the rows extending in a uniform way well over and around the shank. The butt should not be expanded or enlarged, since this usually goes with an abnormally large shank, which makes husking more difficult. The expanded butt is generally due to an enlargement of the cob, and is not well filled over, while the kernels are short and irregular, thus reducing the percentage of corn. On the other hand, the butt may be contracted or filled over too far, in which case the shank is apt to be too small, increasing the tendency of the ears to drop off before husking time.

Uniformity of Kernels. The kernel shape varies with varieties, but whatever the shape, if the corn is a well-selected variety, the kernels should be similar. In judging for uniformity, first remove two kernels from near the middle of each ear and lay them near one end of the ear, with their tips toward you. Place the ears and pairs of kernels side by side, when the comparative size, shape, etc., of the different pairs of kernels may be noted.

The indentation of the kernels is best compared on the ears. Count the number of ears having kernels which are in a general way uniform and score the exhibit accordingly.

Shape of Kernels. In general the shape of the kernel should be that of a wedge, as this shape permits the greatest amount of corn on the cob. The kernels should be of such shape that they fit snugly from tip to crown. If they are too wedge-shaped there is a loss of space at the tips, while if they are too rectangular there will be wide spaces between the rows at the crown. The kernels should not be too thin at the tip, but should be about the same thickness as at the crown. Pointed, thin kernels are often low in vitality and of less feeding value than kernels having plump, well-developed tips. In judging the shape of kernels, remove a few from near the middle of the ear in order to enable you to examine the spacing between the tips and crowns of those remaining on the ear, and to note how closely they fit.

The length and indentation of the kernels should also be noted. A good indentation is of importance, since a deep indentation seems to go with a deep grain. In picking seed ears, only well-indented ones should be selected, as this is the only practical way of keeping up a good depth of kernel.

Space between Kernels. The space between kernels is closely correlated with their shape. Well-shaped kernels should have no lost space between rows, either at tips or crowns. In examining spaces between rows, remove several kernels near the middle of the ear and examine the space between tips of kernels both when looking at the side of the row and when looking at the ends. Then examine the spaces between rows at the top of kernels; this should, as a general thing, be less than one thirty-second of an inch, though this rule cannot be rigidly observed. Too much space is not only associated with poorly shaped and irregular kernels but also with a decreased percentage of corn.

Length of Ears. The length of ear varies with the available fertility of the soil, the amount of moisture, the total heat units included in the growing season, and also with the variety of corn and its hereditary tendency. It is, therefore, influenced in a measure by the seed, and for that reason an ear of desirable length is favored by one of the score cards. The other card does not call for an ear of a certain length, because it is designed for a region in which the distance of a few miles makes a great difference in the size of the ear it is possible to raise, and that it is desirable to select for seed. Even in a region of good rainfall the length of the ear will vary with the latitude, and it is not reasonable to expect a variety to produce as large ears on the northern edge of the corn belt as it does farther south. It will be necessary therefore to have different standards for different localities.

Circumference of Ears. This is determined by the depth of the kernel and the thickness of the cob. The depth of kernel is influenced by the number of heat units in the growing season, by the amount of available fertility and moisture in

the soil, and by inheritance. A deep kernel is desirable because it gives a greater yield of grain than does a shallow kernel. The depth of the kernel that can be raised in any region is limited by the length and temperature of the growing season. While, therefore, a deep kernel is desirable, it should not be so deep that it cannot mature completely in the ordinary growing season of that region. In a humid climate a thin cob is desirable, while in a dry climate a large cob is considered preferable. In Score Card No. 1 the circumference prescribed is as small as is considered consistent with a deep kernel. In Score Card No. 2 no value is given to this point.

Proportion of Corn on Ear. The reason for determining this point is primarily to discourage the production of a large cob, while it also encourages a deep kernel. The effect of this point in connection with the following one is to prevent the growth of an ear unduly large in circumference in proportion to its length.

The proportion of corn on the ear is determined by weighing three representative ears of the exhibit, shelling the grain, and reweighing the cobs. The difference between these weights divided by the weight of the ears gives the per cent of corn on the ear.

Weight of Corn on Ear. While a very large ear of corn is not, under all conditions, desirable for seed, it is to be desired that an ear of a given length should possess a maximum quantity of grain. By requiring an ear of given length to shell out a certain weight of grain a deep kernel is placed at a premium, as is also a heavy kernel. The danger of producing a deep but light-weight kernel is thus avoided.

It is well understood that a deep kernel requires a long growing period for its development. Should the growing

season not be favorable, or should the attempt be made to raise a type of corn having a kernel too deep for the climate

FIG. 16. Typical ears: *A*, shallow-kerneled ear; *B*, deep-kerneled ear

in which it is planted, the result would be a comparatively deep but light-weight kernel. To discourage this the weight requirement is made.

Score Card for Corn, No. 1

(Adopted by the Iowa Corn Growers' Association)

Variety..... Number of Exhibit

	VALUE	STUDENT'S SCORE	CORRECTED SCORE
Trueness to type	10		
Shape of ear	10		
Color of kernels	5		
Color of cob	5		
Vitality, or seed condition . .	10		
Tips of ears	5		
Butts of ears	5		
Uniformity of kernels	10		
Shape of kernels	5		
Length of ear	10		
Circumference of ear	5		
Furrow between rows	5		
Space between kernels at cob .	5		
Proportion of corn to cob . . .	10		

Student's Name Date

Rules for Judging Exhibits of Corn (Score Card No. 1)

Trueness to Type. The ten ears in the sample should possess similar or like characteristics and should be true to the variety which they represent.

Shape of Ear. The shape of the ear should conform to the variety type. Ear should be full and strong in central portion, and not taper too rapidly toward the tip, indicating strong constitution and good yield.

Color of Kernels. Color of grain should be true to variety and free from mixture. For one or two mixed kernels a cut

of one-fourth point should be made; for four or more mixed kernels, a cut of one-half point. Differences in shade of color, as light or dark red, white or cream color, must be scored according to variety characteristics.

Color of Cob. An ear with white cob in yellow corn or red cob in white corn should be disqualified or marked zero. This mixture reduces the value of the corn for seed purposes, indicates lack of purity, and tends toward a too wide variation in time of maturity, size and shape of kernels, etc.

Vitality, or Seed Condition. Corn should be in good market condition and should show good constitution, being capable of producing strong, vigorous growth and yield.

Tips of Ears. The form of tip should be regular; kernels near tip should be of regular shape and size. The proportion of tip covered or filled must be considered. Long, pointed tips, as well as blunt, flattened, or double tips, are objectionable.

Butts of Ears. The rows of kernels should extend in regular order over the butt, leaving a deep depression when the shank is removed. Open and swelled butts, depressed and flat butts with flattened, glazed kernels, are objectionable, and must be cut according to the judgment of the scorer.

Uniformity and Shape of Kernels. The kernels should be uniform in size and shape, making it possible to secure uniformity in dropping with the planter, and consequently a good stand. The kernels should also be not only uniform on the individual ear but also uniform with each ear in the sample. They should also be uniform in color and true to variety type. The kernels should be so shaped that their edges touch from tip to crown. The tip portion of the kernel is rich in protein and oil, and hence of high feeding value. Kernels

with a large germ insure strong, vigorous growth, as well as richness in quality of kernel.

Length of Ear. The length of ear varies according to variety, type, and the characteristics sought for by the individual breeder. Uniformity in length is to be sought for in a sample, and a sample having even length of ears should score higher than one that varies, even if it be within the limits. Usual length of ears for northern section of state, $8\frac{1}{2}$ to $9\frac{1}{2}$ inches; central section, $8\frac{3}{4}$ to $9\frac{3}{4}$ inches; southern section, 9 to 10 inches. Very long ears are objectionable because they usually have poor butts and tips, broad, shallow kernels, and hence a low percentage of corn to cob.

Circumference of Ear. The points made on length of ear, differing with variety types, hold true also in circumference of the ear. The circumference of the ear should be in symmetry with its length. An ear too great in circumference for its length is generally slow in maturing, and too frequently results in soft corn. Dimensions for the northern section of the state are $6\frac{1}{2}$ to 7 inches; central section, $6\frac{3}{4}$ to $7\frac{1}{4}$ inches; southern section, 7 to $7\frac{1}{2}$ inches. Measure the circumference at one third the distance from the butt to the tip of the ear.

Furrows between Rows. The furrows between the rows of kernels should be of sufficient size to permit the corn to dry out readily, but not so large as to lose in proportion of corn to cob.

Space between Tips of Kernels at Cob. This is very objectionable, as it indicates immaturity, weak constitution, and poor feeding value.

Proportion of Corn to Cob. The proportion of corn is determined by weight. Depth of kernels, size of cob, maturity,

furrows, and space at cob all affect the proportion. In determining the proportion of corn to cob, weigh and shell every alternate ear in exhibit. Weigh the cobs and subtract from weight of ears, giving weight of corn; divide the weight of corn by total weight of ears, which will give the per cent of corn. Per cent of corn should be from 86 to 87. For each per cent short of standard a cut of one and one-half points should be made.

Each sample should consist of ten ears of corn.

Score Card for Corn, No. 2

Variety Name..... Number of Exhibit.....

	VALUE	STUDENT'S SCORE	CORRECTED SCORE
Uniformity of exhibit	10		
Shape of ears	10		
Color of cob	5		
Color of kernels	5		
Market condition	10		
Tips of ears	5		
Butts of ears	5		
Uniformity of kernels	10		
Shape of kernels	10		
Space between kernels	5		
Weight of grain	25		

Student's Name..... Date.....

Rules for Judging Exhibits of Corn (Score Card No. 2)

Uniformity of Exhibit. The ears in an exhibit should be similar in size, shape, color, and indentation. For each ear deficient in these respects cut the exhibit one point.

Shape of Ears. The ears should be cylindrical, or nearly so. Cut the exhibit one point for each ear deviating from this requirement.

Color of Cob. The cobs should be uniformly red or uniformly white. For each white cob in an exhibit in which the red predominate, cut the exhibit one-half point. Do the same for each red cob in an exhibit of white cobs.

Color of Kernels. For each white-crowned kernel in a yellow or red variety cut the exhibit one-tenth point. For each yellow kernel in a white variety give the same cut.

Market Condition. The corn should be well matured, firm, and sound. For each ear deficient in these respects cut the exhibit one point.

Tips of Ears. The tips of the ears should be covered with regular, uniform kernels. Add together the lengths of protruding cobs on all ears of the exhibit, and cut at the rate of one-half point for each inch.

Butts of Ears. The rows of kernels should be even and swell out evenly beyond the end of the cob. Cut the exhibit one-half point for each poorly filled butt, and one-fourth point for each flat butt.

Uniformity of Kernels. The kernels should possess similar characters. Cut the exhibit one-half point for each deficient ear.

Shape of Kernels. The kernels should have a wedge shape on the broad side, and on the narrow side the edges should be parallel. Cut one point each for each objectionable ear.

Space between Kernels. The rows of kernels should not be more than one thirty-second of an inch apart at any part of the row. If more than one sixteenth of an inch apart, cut

one-half point ; if less than that, but more than one thirty-second, cut one-fourth point for each ear.

Weight of Grain. The weight of grain on an average ear should come up to the following requirements :

Length of ear 12 inches and over, weight of grain 17 ounces.

Length of ear 11 to 12 inches, weight of grain 15 ounces.

Length of ear 10 to 11 inches, weight of grain 14 ounces.

Length of ear 9 to 10 inches, weight of grain 13 ounces.

Length of ear 8 to 9 inches, weight of grain 11.5 ounces.

Length of ear 7 to 8 inches, weight of grain 9.5 ounces.

Length of ear 6 to 7 inches, weight of grain 8 ounces.

For each ounce below the number required by an ear of given length cut the exhibit two points.

TESTING CORN FOR VIABILITY

Standard for germination, 95–98 per cent.

The importance of making germination tests of corn cannot be emphasized too strongly, since seed corn will often have a fair outward appearance and yet germinate poorly.

When the germinating power of corn is very low, and reliable seed is hard to pick out, it is often desirable to make germination tests of each ear separately.

To do this, first number the ears by slipping a piece of cardboard containing the number between two rows. Remove two kernels from the butt, two from the middle, and two from the tip of each ear. Then, taking the germinator described on page 94, mark off the blotting paper in the bottom into two-inch squares, numbering each. Now put the grains from each ear in their respective squares, and allow to germinate.

In this way several hundred ears may be tested at once.

For testing a large lot of corn in the ear select 100 ears at random and take six kernels from each ear, as described above. Corn seems to germinate more poorly near the butt than at any other point. Place seed in germinator. Germination should begin in about two days and should be complete in six.

For best results keep temperature as near 80° to 90° F. as possible, and never let fall below 60° F.

COMMERCIAL GRADING OF CORN

The grades of corn are usually designated as "White Corn," "Yellow Corn," or in case of a mixture of the two (amounting to more than 25 per cent) it is simply called "Corn."

Usually three grades of white and yellow corn are made and four grades of the mixed corn. In examining and grading corn the student should take into consideration the following points.

Notes on the Quality of Corn

Color. No. 1 Corn should be true to color, but in grades 2 and 3 considerable mixture is allowed, varying from 10 to 25 per cent.

Soundness. Good corn should not only be thoroughly cleaned up but should also be reasonably free from decayed or cracked kernels. Cracked kernels often indicate that the corn was damp when shelled. Any considerable per cent of chaffy or shrunken kernels injures both the feeding and milling value of the corn.

Moisture. Corn in a wet or heated condition cannot be graded.

Go over each sample carefully and make out a short report on each, giving first the commercial grade, and then the amount of mixture, if mixed, also the kind and nature of any impurities or injury the grain may have suffered from exposure, sprouting, or heating in crib or bin. The following form of report is suggested :

SAMPLE NO.	GRADE	REMARKS

For this work from 20 to 25 samples of corn are provided. These should include samples of pure yellow and white corn of the various grades, in various stages of cleanliness, dampness, etc. Also samples of mixed corn, starting in with pure white and yellow and mixing them in various proportions.

*Corn-Inspection Rules*¹

No. 1 Yellow Corn shall be yellow, sound, dry, plump, and well cleaned.

No. 2 Yellow Corn shall be three fourths yellow, dry, reasonably clean, but not plump enough for No. 1.

No. 3 Yellow Corn shall be three fourths yellow, reasonably dry, and reasonably clean, but not sufficiently sound for No. 2.

No. 1 White Corn shall be sound, dry, plump, and well cleaned.

¹ Rules adopted by the Board of Railroad and Warehouse Commissioners for the inspection of grain at Chicago.

No. 2 White Corn shall be seven eighths white, dry, reasonably clean, but not plump enough for No. 1.

No. 3 White Corn shall be seven eighths white, reasonably dry, and reasonably clean, but not sufficiently sound for No. 2.

No. 1 Corn shall be mixed corn of choice quality, sound, dry, and well cleaned.

No. 2 Corn shall be mixed corn, dry and reasonably clean, but not good enough for No. 1.

No. 3 Corn shall be mixed corn, reasonably dry and reasonably clean, but not sufficiently sound for No. 2.

No. 4 Corn. Corn that is badly damaged, damp, or very dirty, shall be graded no higher than No. 4.

Corn that is wet or in heated condition shall not be graded.

SECTION III — OATS

CLASSIFICATION OF SPECIES

Order.....	<i>Gramineæ</i>
Genus.....	<i>Avena</i>
Species.....	<i>Sativa</i>

The cultivated varieties are sometimes classified according to the form of the panicle, and are considered by some botanists as distinct species. The “common oat” (*Avena sativa*) comprises those varieties having spreading panicles, and the “Tartarian oat” (*Avena orientalis*) comprises varieties with close, erect panicles, commonly called “side oats,” while the other is called “branch oats.”

There is also a type (*Avena nuda*) from which the hull is removed in threshing. Varieties of this are found in both of the above groups.

The hulled varieties are also divided, according to the color of the hull, into white, gray, red, and black oats.

The oat differs from the other cereals in having its heads in the form of panicles instead of spikes, and the grain is not attached directly to the main stem of the plant.

In form of grain and height of straw varieties differ considerably.

A good oat grain should be fairly plump, have a thin hull, and weigh from 32 to 38 pounds per measured bushel.

The stalk should be of medium height and sufficiently strong and stiff to stand erect.

As in the case of most other cereals, the varieties of oats are very numerous and adapted to different conditions.

In regard to yield and quality there seems to be in general no particular difference between oats of different color or

oats with open or closed panicles. The differences seem to be due solely to variety characteristics and conditions affecting growth.

The shape of the grain varies considerably in different varieties, some being very long and rather slender, while others are of a short and thicker type.

In the southern regions the proportion of hull to berry tends to increase.

FIG. 17. Types of oat heads: A, panicked oats;
B, side oats

Remove hulls of several varieties and get proportion by weighing. (Hulls are more easily removed if soaked in a dilute solution of potassium hydrate or 33 per cent alcohol for a few minutes.)

The feeding value is decreased by a large proportion of hull. The proportion of hull varies with its thickness and with the size of the berry.

LABORATORY STUDY OF CHARACTERS

Examine in head samples of common varieties of side and panicle oats.

Draw a branch and two or three spikelets.

Dissect out carefully a spikelet and draw its parts in their relative position.

Now examine each head carefully and note down its characteristics in the "Outline for describing Oats," using the list of descriptive terms as a guide.

TERMS FOR DESCRIBING OATS

Panicle*Shape*

	{	Open (Fig. 17, <i>A</i>).	
1.	{	Spreading.	
	{	Compressed.	
	{	Side panicle (Fig. 17, <i>B</i>).	{ Loose.
2.	{	Length (inches).	{ Compressed.

Color

	{	Whitish.
	{	Yellowish.
	{	Yellow brown.
1.	{	Brown.
	{	Reddish.
	{	Black.
	{	Gray.

Spikelet

1.	{	Spreading.
	{	Narrow.
2.		Number of grains, 1, 2, 3.

Grain*Shape*

1. { Long (Fig. 18, *A*).
Medium.
Short (Fig. 18, *B*).
2. { Cylindrical.
Conical (Fig. 18, *B*).
Wedge-shaped (Fig. 18, *A*).

Crease

1. { Full.
Deep.

Weight of 100 grains.

Tip

1. { Long (Fig. 21, *A*).
Medium.
Short (Fig. 21, *B*). } Refers to extension of hull
beyond the naked berry.
2. { Pointed (Fig. 18, *A*).
Blunt (Fig. 18, *B*).

Hull

1. Per cent.

Color

1. { Whitish.
Yellowish.
Brownish.
Reddish.
Black.

Dorsal awns

1. { Long.
Medium.
Short.
None.

Color

1. { Whitish.
Brownish.
Yellowish.
Black.
2. Brown or black at base and lighter at tip.

FIG. 18. Oat spikelets and grains. The upper figures show an entire oat spikelet, both in its natural form and when torn apart, with all parts named. The lower figures show two types of oat grains: *A*, long, pointed; *B*, short, blunt

Use the following outline in describing oats in head. Write in the blank space under the number of the oat being described, and opposite the proper heading, the term which applies, using the list of "Terms for describing Oats" as a guide.

OUTLINE FOR DESCRIBING OATS

Panicle

Shape

- 1.....
- 2.....

Color

- 1.....

Spikelet

- 1.....
- 2.....

Grain

Shape

- 1.....
- 2.....

Crease

- 1.....

Weight of 100 grains (grams).....

Tip

- 1.....
- 2.....

Hull

- 1.....

Color

- 1.....

Dorsal awn

- 1.....

Color

- 1.....
- 2.....

Student's Name..... Date.....

A STUDY OF THE MATURE PLANT OF OATS

(Prepared by A. T. Wianeko, Purdue University)

Use the material provided by the instructor, and describe according to the following outline :

1. Length of panicles in inches (average of five panicles from base of lower whorl to tip of flowering glume of upper spikelet).....
2. Number of whorls (average of five panicles)
3. Number of main branches (average of five panicles)
4. Variation in length of pedicel of spikelet.....to.....
5. Number of grains per spikelet
6. Relative weight of lower and upper grains of spikelet: weight of 25 lower grains.....; weight of 25 upper grains.....
7. Number of grains (average of five panicles)
8. Weight of grains (average of five panicles).....; weight of 100 grains
9. Per cent of kernel : weight of 100 grains; weight of 100 kernels.....: per cent.....
10. Plumpness : plump, medium, inflated.
11. Color of grain : light yellow, yellow, gray, reddish brown, black.

FIG. 19. A set of ten samples of oats ready for study. The cups hold one pint each

EXAMINING THE QUALITY OF OATS

For this exercise ten or twelve samples in cups are provided, as in the work with wheats. These samples should include

at least one sample of each of the principal types, and should exhibit as wide a range of qualities as possible. First fill out a card for each sample, similar to Form No. 2, giving an analysis of each. The meanings of all the terms are apparent enough not to require explanation unless it be "large," "medium," and "small," under "Size of Grain."¹ This data is only intended to give some idea of the uniformity in size of grains in the particular sample under consideration,

FIG. 20. A tin pint cup filled with oats, and the report card made out

and not the relative size when all varieties are considered.

After a card has been made out for each sample, arrange the samples according to weight per bushel. Explain in writing

¹ The term "grain" is used to designate the hull and the berry it contains.

the various causes to which the light weights of the five lighter samples are apparently due.

Make out a written statement showing which is the best oat, (*a*) from the feeder's standpoint ; (*b*) from the seedsman's standpoint ; (*c*) from the miller's standpoint.

Report Card

OATS

No.....	Variety.....	
Weight per bushel.....		lbs.
Color {	Whitish.....	per cent
	Yellowish.....	per cent
	Brownish.....	per cent
	Reddish.....	per cent
	Black.....	per cent
Size of grain {	Large.....	per cent
	Medium.....	per cent
	Small.....	per cent
Weight of 100 grains.....		grams
Hull.....		per cent
Must.....		per cent
Unsound grain.....		per cent
Foreign matter.....		per cent
Viability.....		per cent

[FORM No. 2]

Notes on the Quality of Oats

Mustiness. Oats should be free from must, as it injures the palatability and feeding value of the grain ; it also gives horses a cough.

Purity. Oats should be fairly clean, but more foreign matter is allowed in oats than in corresponding grades of other grain.

An occasional kernel of corn or wheat is not so objectionable in a grain used largely for feeding purposes as in a grain for milling. Weed stems and seeds are not only worthless

but may give a bad taste to the grain.

FIG. 21. Structure of the oat grain. The upper figures illustrate a short thick and long slender type of oat grain. They are cut through at the crease. The lower figures are transverse sections, drawn to scale

Plumpness. Other things being equal, a plump grain is always preferred, since it usually has a less proportion of hull and consequently higher feeding value.

Soundness. Decayed and weather-beaten grain not only suffers in appearance, but the feeding quality is injured, since only a small amount is sufficient to injure that sweet, palatable flavor which bright, clean oats should have.

Weight. When different varieties of oats are being compared the weight per bushel is not always a fair indication of their relative value. Some varieties of oats have an awn on the back of each grain, which prevents the grains from settling together closely in the measure and giving a high weight per bushel, although the individual grains may be of the best quality. Other varieties

have a long projection of the hull over the berry, or a rough hull, and for these reasons it may often happen that a smooth-grained, awnless variety will weigh more per bushel than a rough-hulled, awned variety of oats, although the individual grains are not as plump or well developed. Even in the same variety the different conditions under which the oats may be cut and threshed will affect the weight per bushel. However, in oat varieties of similar character the weight per bushel may be taken as a fair indication of feeding value, the lighter oats having a larger proportion of hull to berry than the heavier.

JUDGING OATS

First score the ten samples used in the last exercise, making use of the same data. The student should then have access to a general collection of oat samples. It is much better if these can be supplied in peck or half-bushel lots.

Score Card for Oats

Variety Name..... Sample Number.....

	CREDIT	1	2	3	4
Uniformity, 20%					
(a) In color	10				
(b) In size	10				
Quality, 80%					
(a) Weight per bushel . . .	25				
(b) Soundness and dirt . .	10				
(c) Per cent of hull . . .	25				
(d) Size of grain	10				
(e) Must, smut	10				
Total	100				

Student's Name..... Date.....

Explanation of Score Card

In this score card oats are judged entirely from the feeder's standpoint. It is not possible to make a score card by which an oat could be judged at the same time from both the feeder's and the miller's standpoint, and also judge the grain for seed. Different points would be used in each case, and different values given them.

Uniformity in Color. Uniformity in color and size are of only minor importance to the feeder. Divide the sample according to the color of the grains. Let the class having the largest number determine the color. Cut one point for each two per cent of other colors.

Uniformity in Size. Divide the sample into two parts according to size of grain. Estimate per cent of small grains by count. Cut one point for each four per cent of small grains.

Weight per Bushel. The weight per bushel is a very important consideration in estimating the value of an oat for feeding purposes. A heavy weight indicates that the grain was well matured and filled out. In the same variety a heavy oat usually has a less per cent of hull, and consequently a higher feeding value than a light oat. The best oats should weigh 38 pounds per bushel. Cut one point for every pound light down to 32 pounds per bushel, and two points for every pound light below this.

Soundness and Dirt. Sprouted or decayed grains have little more value than so much trash, and may be regarded as such for judging purposes. Separate all unsound grains and dirt, estimate the per cent by weight, and cut two points for each one per cent. This cut is not limited to ten points, but may be indefinite.

Per Cent of Hull. The percentage of hull varies with varieties, the locality in which the oat is grown, and also depends on how well and perfectly the grain was matured. In growth the hull and bran develop first, and the starch is deposited last. However, if from any cause such as dry weather, poor soil, injury from insects, etc., the grain is prevented from maturing perfectly, the development of the starch is somewhat curtailed, and consequently the percentage of hull is higher. A good oat may have as high as 30 per cent hull. Cut two points for every per cent of hull above this.

Size of Grain. Size varies greatly with varieties, but 100 grains should weigh 3 grams in heavy oats. Cut one point for every two tenths of a gram less.

Must and Smut. If must or smut is very apparent, the sample should be cut 10 points.

COMMERCIAL GRADING OF OATS

The work in commercial grading is carried out by first examining a set of samples representing the commercial grades.

Then as large a set of miscellaneous samples as possible should be examined and graded according to official inspection rules. The samples previously examined in studying oats should be graded, as the student already has a good knowledge of the comparative value of these.

*Oat Inspection Rules*¹

No. 1 White Oats shall be white, sound, clean, and reasonably free from other grain; weight 32 pounds.

¹ Rules adopted by the Board of Railroad and Warehouse Commissioners for the inspection of grain at Chicago.

No. 2 White Oats shall be seven eighths white, sweet, reasonably clean, and reasonably free from other grain; weight 28 pounds or above.

No. 3 White Oats shall be seven eighths white, but not sufficiently sound and clean for No. 2; weight 22 pounds or better.

No. 4 White Oats shall be seven eighths white, damp, badly damaged, musty, or for any other cause unfit for No. 3.

No. 1 White Clipped Oats shall be white, sound, clean, reasonably free from other grain, and shall weigh not less than 36 pounds to the measured bushel.

No. 2 White Clipped Oats shall be seven eighths white, sweet, reasonably clean, reasonably free from other grain, and shall weigh not less than 34 pounds to the measured bushel.

No. 3 White Clipped Oats shall be seven eighths white, not sufficiently sound or clean for No. 2, and shall weigh not less than 28 pounds to the measured bushel.

No. 1 Oats shall be mixed oats, sound, clean, and reasonably free from other grain.

No. 2 Oats shall be sweet, reasonably clean, and reasonably free from other grain.

No. 3 Oats shall be mixed oats, not sufficiently sound and clean for No. 2.

No. 4 Oats shall be all mixed oats that are damp, badly damaged, musty, or for any other cause unfit for No. 3.

In examining and grading the samples of oats take up each point separately, as in wheat, making notes of your observations and reporting on each after the manner of the table on the following page.

NUMBER OF SAMPLE	GRADE	REMARKS
1	No. 2 Oats	Weight 30 lb. per bushel; grains plump; slight mixture of barley; sweet and bright.

TESTING OATS FOR PURITY

Standard for purity 99 per cent.

Thoroughly mix the oats to be tested and take out about a half-pint sample. Spread this on a table and carefully separate out the impurities. Then find by weight the amount of pure seed, as well as the foreign matter, and from this calculate the per cent of purity.

An oat sample may sometimes contain as much as 5 per cent foreign matter and still pass the casual observer as a fairly clean sample.

TESTING OATS FOR VIABILITY

Standard germination 95 per cent.

If taking a sample for germination from a bin, do not take it from one place, but mix up thoroughly several scoopfuls taken from different parts of the bin, and then from this take a small sample and pick out at random 100 grains. Place these in a germinating apparatus as described on page 94.

Moisten daily and keep at a temperature of 80° to 90° F. Germination should begin in three days. As soon as the radicle is one fourth inch long the grain has germinated.

Remove all sprouted grains daily until germination ceases. Then by counting the number which failed to sprout, and subtracting this from 100, you have the per cent of germination.

HOT-WATER TREATMENT FOR EITHER LOOSE OR COVERED SMUT IN OATS¹

(Prepared by A. N. Hume, University of Illinois)

Place a sufficient amount of seed oats in a bag or basket which will readily admit water, and immerse for ten minutes in hot water at 133° F.; then cool quickly by immersing in cold water or by stirring thoroughly while drying.

Having treated the seed oats as above, make a duplicate germination test of the treated seed, and also a duplicate germination test of untreated seed to serve as a check.

Report as follows:

Treated Seed

Per cent of germination: (1) _____, (2) _____; Av. _____

Untreated Seed

Per cent of germination: (1) _____, (2) _____; Av. _____

Does the hot-water treatment injure the vitality of the seed?

Student's Name..... Date.....

FORMALIN TREATMENT FOR EITHER LOOSE OR COVERED SMUT IN OATS¹

(Prepared by A. N. Hume, University of Illinois)

Treat seed by sprinkling or immersion for 30 minutes with a solution of 1 pound of formalin (40 per cent solution of formaldehyde) to 50 gallons of water.

In all treatments it is well to first stir the seed into a tub of cold water and skim off the smut balls which rise to the surface. After treatment the drying may be hastened by using slaked lime.

¹ This treatment can also be used for stinking smut in wheat.

Having treated a sufficient quantity of seed oats as above, make a duplicate germination test of the treated seed, and also a duplicate germination test of untreated seed to serve as a check.

Report results as follows:

Treated Seed

Per cent of germination : (1) , (2) ; Av.

Untreated Seed

Per cent of germination : (1) , (2) ; Av.

Does the formalin treatment injure the vitality of the seed?

Student's Name Date

SECTION IV — BARLEY

CLASSIFICATION OF SPECIES AND VARIETIES

Order.....	<i>Gramineæ</i>
Genus.....	<i>Hordeum</i>
Species.....	<i>Sativum</i>

Cultivated barleys include a number of types, or races, which by some are considered as subspecies and classified as follows :

- (1) Two-rowed barley.....*Hordeum sativum distichon*
- (2) Six-rowed barley.....*Hordeum sativum hexastichon*

The two-rowed barleys commonly grown are characterized by their large, plump grain. In Europe these barleys are used almost exclusively for malting, and hence the name “malting barleys” has come to be generally applied to them. However, in America the six-rowed barleys are generally used for this purpose.

The six-rowed barleys include the “naked,” or “hull-less” varieties, as well as most of our common cultivated barleys. The six-rowed barleys are generally more prolific than the two-rowed, and are most generally grown in this country. The grains of six-rowed barleys are smaller and not so plump as those of the two-rowed barleys, but are higher in nitrogen.

The varieties of barley are numerous, but only a comparatively few are grown in the United States.

Carefully examine samples of each of the above types of barley, including samples of both black and white hulless barley.

FIG. 22. Types of barley spikes: *A*, two-rowed brewing barley; *B*, six-rowed hulless barley

Make drawings from a spike of each type, showing the imbricated view.

Note that the berry of ordinary barley is tightly inclosed by the flowering glume, called the "hull," while in hulless

barleys the flowering glume and palet do not adhere closely and the berry is free.

In this respect hulled barley is similar to oats, and hullless to wheat.

LABORATORY STUDY OF CHARACTERS

Typical samples in the spike and of the threshed grain are provided. Carefully describe both the spike and grain of one or more samples of the principal types of barley, as the two-, four-, and six-rowed barleys, and black and white hullless barleys.

The characteristics are obvious enough, so that with a little careful comparison there should be no trouble in finding the proper adjective in the descriptive list.

Use the outline for describing barleys, filling it out carefully.

TERMS FOR DESCRIBING BARLEYS

Spike

1. { Two-rowed (Fig. 22, *A*). } This refers to the number of rows
 { Six-rowed (Fig. 22, *B*). } of grain on the spike.
2. { Awned (Fig. 22, *A*).
 { Partly awned (Fig. 22, *B*).
 { Awnless.
3. Length (inches).
4. { Open (Fig. 22, *A*). } Has reference to how close or far
 { Compact (Fig. 22, *B*). } apart the spikelets are on the
 { Crowded. } rachis.

Shape

1. { Tapering toward tip. } When upper spikelets are appressed.
 { Tapering both ways. } When spikelets at both base and tip
 { Uniform (Fig. 22, *A*). } are more appressed than those at middle.

2.	$\left\{ \begin{array}{l} \text{Tip acute (Fig. 22, A).} \\ \text{Tip blunt (Fig. 22, B).} \end{array} \right\}$	When terminal spikelets are not well filled out.
		Terminal spikelets well filled out.
3.	$\left\{ \begin{array}{l} \text{Base abrupt.} \\ \text{Base tapering.} \end{array} \right\}$	Basal spikelets well filled out.
		Basal spikelets not well filled out.
4.	Sterile spikelets, 1, 2, 3, etc.	

Color

1. { Whitish.
Yellowish.
Yellowish brown.
Brown.
Black.

Awns

1. { Long (length 5 inches or more).
Medium (length 3 to 5 inches).
Short (length less than 3 inches).
2. { Parallel (Fig. 22, *B*).
Spreading (Fig. 22, *A*). } Refers to the relative position
of the awns to the head.
3. { Deciduous.
Partly deciduous (Fig. 22, *B*).
Persistent (Fig. 22, *A*). } This refers to the dropping of
the awns at maturity. The
awns all drop off on some
varieties, while on others
they are very persistent.

Color

1. { Whitish.
Yellowish.
Brownish.
Black.

Spikelet

(This is not a spikelet in the botanical sense, but really a mesh of three spikelets.)

1. Number grains per spikelet (1, 2, 3).
2. Number of sterile flowers. (Refers to sterile flowers in a spikelet.)

Size

1. {	Broad (Fig. 23, C).	} This depends largely on the shape of the grain and how well it is developed.
	Medium (23, B).	
	Narrow (Fig. 23, A).	

Outer Glume. (In barleys these are very narrow and pointed.)

1. {	Awned (Fig. 23, B).	} The outer or empty glume should not be confused with the flowering or seed-bearing glume.
	Awn-pointed.	
	Awnless (Fig. 23, D).	

Grain

1. {	Inclosed in flowering glume.	} This is the distinguishing characteristic between the naked or hulless barley and the ordinary kind. In the latter the grain is so tightly inclosed that it is not freed in threshing.
	Free (naked).	

FIG. 23. Types of barley spikelets: A, spikelet from two-rowed barley; B, spikelet from six-rowed barley; C, a six-rowed hulless barley; D, a white hulless and awnless barley; E shows a barley spikelet torn apart

2. $\left\{ \begin{array}{l} \text{Hard.} \\ \text{Medium.} \\ \text{Soft.} \end{array} \right\}$ This point is most easily determined by biting or cutting the grains and comparing with standard samples.

Shape

1. $\left\{ \begin{array}{l} \text{Long.} \\ \text{Medium.} \\ \text{Short.} \end{array} \right\}$ Different varieties of barley show considerable variation in size and ratio of length to diameter. Pick out about six typical grains to examine for these points.
2. $\left\{ \begin{array}{l} \text{Thin.} \\ \text{Medium.} \\ \text{Plump.} \end{array} \right\}$

Crease

1. $\left\{ \begin{array}{l} \text{Deep.} \\ \text{Medium.} \\ \text{Full.} \end{array} \right\}$ Cut cross sections of several typical grains.

Cross section

1. $\left\{ \begin{array}{l} \text{Horny.} \\ \text{Dull.} \\ \text{Starchy.} \end{array} \right\}$ This point is determined by making cross sections and examining carefully. Where only part of the grains show one characteristic and the rest some other, the per cent of each kind should be expressed.

Color

1. $\left\{ \begin{array}{l} \text{Black.} \\ \text{Purple.} \\ \text{Purplish.} \\ \text{Brown.} \\ \text{Yellowish.} \\ \text{Whitish.} \end{array} \right\}$ When black hulless barleys are fully matured they are purplish black in color, but when cut very green they are often a yellowish white in color, with only a tinge of purple.

Weight of 100 grainsgrams

OUTLINE FOR DESCRIBING BARLEYS

Spike

- 1.....
 2.....
 3.....
 4.....

Shape

- 1.....
 2.....
 3.....
 4.....

Color

- 1.....

Awns

- 1.....
 2.....
 3.....

Color

- 1.....

Spikelet

- 1.....
 2.....

Size

- 1.....

Outer Glume

- 1.....

Grain

- 1.....
 2.....

Shape

- 1.....
 2.....

Crease

- 1.....

Cross section

- 1.....

Color

- 1.....

Weight of 100 grains (grams)

EXAMINING THE QUALITY OF BARLEY

For this exercise some ten samples of barley are provided in cups. The widest possible range of type and quality should be included. First fill out a report card for barley, Form No. 3, for each sample. The card gives an analysis of the sample. By using the score card the value of the sample from a brewer's standpoint may be obtained.

Report Card

BARLEY

No.....	Variety
Weight per bushel	lb.
Color	{ Good color.....per cent { Somewhat discolored.....per cent { Badly discolored.....per cent
Texture	{ Vitreous.....per cent { Starchy.....per cent
Size	{ Large.....per cent { Small.....per cent
Berries exposed or cracked through injury in threshing.....	per cent
Sprouted (number)	per cent
Bin burnt, decayed, etc.	per cent
Weight of 100 grains	grams
Foreign matter.....	per cent
Viability.....	per cent

[FORM No. 3]

Using Report Card for Barley. The weight per bushel will have to be obtained from a large sample by the ordinary method (see pp. 98, 99). For obtaining the rest of the data see the "Explanation of the Score Card." The viability can only be obtained by testing the sample in a germinator.

In judging barley from the brewer's standpoint only good unbleached samples can be used, while from a feeder's standpoint a slight discoloration would be no objection.

The price of white barley is governed by the brewing qualities of the grain. Any discoloring or bleaching disqualifies it for this purpose.

A few points to be observed in grading barleys are as follows :

Notes on the Quality of Barley

Color. White barleys should be a clear, light color, with no tint of yellow or brown.

Bleaching and discoloring caused from exposure to the weather is probably the most common cause of injury to white barleys. Bleaching not only disqualifies barley for malting purposes by injuring the color of the product, but the wetting and drying which the grain is subjected to when bleached injures its malting properties.

Black barleys when fully matured are usually a blue black, but if harvested before fully matured, many of the grains will be brownish, with varying degrees of purple or blue, shading to almost black.

Texture. The texture of barleys varies from quite hard and horny (vitreous in appearance) to a crumbly texture, white and very starchy.

A good way to examine both the texture and hardness of a barley at the same time is to bite several grains in two. The difference in hardness and texture is directly correlated with the variation in protein content. The very soft and starchy barleys contain the least proteids, about 8 or 10 per

cent, while barleys with a hard, horny texture, and usually vitreous appearance, sometimes contain as high as 15 per cent proteids.

Size and Weight of 100 Grains. The grains of two-rowed barleys are larger than the grains of six-rowed barleys. Large-grained barleys, even of the same type, seem to be generally more starchy and contain less protein than the smaller-sized grains. It is for this reason that the German brewers select the large-grained, two-rowed barleys, and American brewers the smaller-grained, six-rowed barleys.

Brewing Qualities. German brewers generally prefer barleys of very low proteid content, — from 7 to 9 per cent. However, American brewers are using with good success many western and northern barleys containing as high as 12 to 14 per cent proteids.

The difference in opinion seems to be due largely to the difference in methods of brewing, and the special qualities sought for in the two countries. For example, in America large quantities of corn or rice are used with the barley in brewing, which necessitates the use of a barley of much higher diastatic power than is required in Europe where the barley alone is used.

FIG. 24. A half-bushel galvanized iron box used in storing grain samples; also used in the general practice work of judging and grading grains

JUDGING BARLEY

Score Card for Barley

Variety Name..... Number of Exhibit.....

	CREDIT				
Uniformity, 50%					
(a) Color	20				
(b) Texture	20				
(c) Size	10				
Quality, 50%					
(a) Weight per bushel . . .	10				
(b) Injury in threshing . .	15				
(c) Sprouted, bin-burned, decay, etc.	15				
(d) Foreign matter	10				
Total	100				

Student's Name Date.....

Explanation of Score Card

Barley is judged entirely from the brewer's standpoint, since it is the brewing qualities of a barley that determine its market value. Brewing barley sells 10 to 20 per cent higher than feeding barley. In judging barley the following characteristics are taken into consideration.

Uniformity. Whatever the character or the variety of a barley may be, it is very important that it be uniform in quality. For example, in germination it is essential that all the grains germinate at one and the same time; but if part of the barley germinates in thirty hours, part in forty hours,

and part in sixty hours, it is not as valuable for malting purposes as a barley which germinates uniformly at some one period. Where a barley has been exposed to the weather until considerably damaged, part of the grains may be sprouted, part more or less affected, and another part uninjured. Such a barley cannot germinate evenly. Though it may have been a first-class barley of heavy weight to begin with, it is not as valuable for malting purposes as a lighter barley of uniform sprouting qualities. For similar reasons barley should be uniform in color, variety, size of grain, age, storage conditions, etc.

Uniformity in Color. Separate a sample into two or three parts according to color, i.e. different degrees of discoloring. Let the class having the highest number determine the color of the sample, and cut one point for each one per cent in other classes.

Uniformity in Texture. Barleys have both horny and starchy textures, the same as wheats. For brewing purposes they should all be uniformly one or the other. Divide the sample into two parts according to texture and hardness of berries. Let the part having the highest number determine the classification of the sample, and cut one point for each one per cent of other kind.

Uniformity in Size. Divide the sample into two parts, according to size of grain. Let the part having the largest volume or weight determine the classification, and cut one point for each two per cent of other sizes.

Weight per Bushel. Good malting barley should weigh from 40 to 50 pounds per bushel. While a heavy-weight barley usually has a less per cent of hull and a higher per cent of starch, yet other considerations are of so much

importance that a forty-pound barley may easily outsell a much heavier one. Barleys are largely sold by sample. However, other things being equal, a heavy barley is preferred.

FIG. 25. A view of the laboratory storeroom

Cut one point for each pound below 45 pounds per bushel.

Injury in Threshing.

If barley is threshed too "close," many of the awns will be broken so short that the tip of the berry will be exposed or the hull will be split down the back. Grains so injured absorb water rapidly and do not malt uniformly with unin-

jured grains. Cut one point for each per cent so injured.

Sprouted, Bin-Burned, or Decayed Grains. Estimate by counting and cut one point for each one per cent off.

Foreign Matter. Estimate per cent by weight and cut one point for each one per cent.

COMMERCIAL GRADING OF BARLEY

The work in commercial grading is carried out by first examining a set of standard samples representing the commercial grades; then as large a set of miscellaneous samples as possible should be examined and graded according to official inspection rules. The samples previously examined in studying barley should be graded, as the student already has a good knowledge of these.

*Barley Inspection Rules*¹

No. 1 Barley shall be sound, plump, bright, clean, and free from all other grain.

No. 2 Barley shall be of healthy color, not sound enough and plump enough for No. 1, reasonably clean, and reasonably free from other grain.

No. 3 Barley shall include slightly shrunken and otherwise slightly damaged barley not good enough for No. 2.

No. 4 Barley shall include all barley fit for malting purposes not good enough for No. 3.

No. 5 Barley shall include all barley which is badly damaged or for any reason is unfit for malting purposes, except that barley which has been chemically treated shall not be graded at all.

Black Barley. The grades Nos. 1, 2, 3, and 4 Black Barley shall conform in all respects to grades Nos. 1, 2, 3, and 4 Barley, except they shall be of the black varieties of barley.

In examining and grading barleys the brewing and feeding qualities should be kept in mind. Note with care the color, texture, and brewing and feeding qualities of each sample. Report on these points with the grade of the sample, after the following manner:

NUMBER OF SAMPLE	GRADE	REMARKS
2	No. 3 Barley	Plump but quite bleached; good feeding value.

¹ Rules adopted by the Board of Railroad and Warehouse Commissioners for the inspection of grain at Chicago.

SECTION V — HAY PLANTS

LABORATORY STUDY OF CHARACTERS

The following outline is used in the study of common cultivated grasses and millets. By following the outline one's attention is called to the distinguishing characteristics of each kind, giving not only a means of identification but a good knowledge of the grass.

OUTLINE FOR DESCRIBING GRASSES

The stem and leaves

Height.....
Color of stem.....
Color of leaves.....
Number of leaves.....

Head

Awned or awnless.....
Panicled, compact, or spiked.....
Size (give length and diameter).....
Color of awns.....
Color of chaff.....

Root

Does it spread from rootstocks?.....
Is it a sod-forming or bunch grass?.....

Seeds

Size (give average length in inches).....
Color (general color).....

General Notes

Is seed free or inclosed in scales?.....
Weight per bushel.....
Amount sown per acre.....
Vitality.....

Drawings of Seeds. Make drawing from convex side.
Make drawing of cross section.

COMMERCIAL GRADING OF HAY

*Hay and Straw Inspection Rules*¹

Choice Timothy Hay shall be Timothy not mixed with over one twentieth other grasses, properly cured, bright natural color, sound, and well baled.

No. 1 Timothy Hay shall be Timothy not more than one fifth mixed with other tame grasses, properly cured, good color, sound, and well baled.

No. 2. Timothy Hay shall include Timothy not good enough for No. 1, not over one third mixed with other tame grasses, sound, and well baled.

No. 3 Timothy Hay shall include all hay not good enough for other grades, sound, and well baled.

No. 1 Clover Mixed Hay shall be Timothy and Clover mixed, with at least one half Timothy, good color, sound, and well baled.

No. 2 Clover Mixed Hay shall be Timothy and Clover mixed, with at least one third Timothy, reasonably sound, and well baled.

No. 1 Clover Hay shall be medium Clover, not over one twentieth other grasses, properly cured, sound, and well baled.

No. 2 Clover Hay shall be Clover, sound, well baled, not good enough for No. 1.

No Grade Hay shall include all hay badly cured, musty, stained, threshed, or in any way unsound.

Choice Prairie Hay shall be Upland Hay of bright color, well cured, sweet, sound, and reasonably free from weeds.

¹ Rules adopted by the Chicago Board of Trade for the inspection of hay and straw.

No. 1 Prairie Hay shall be Upland, and may contain one quarter Midland of good color, well cured, sweet, sound, and reasonably free from weeds.

No. 2 Prairie Hay shall be Upland of fair color, or Midland of good color, well cured, sweet, sound, and reasonably free from weeds.

No. 3 Prairie Hay shall be Midland of fair color, or slough of good color, well cured, sound, and reasonably free from weeds.

No. 4 Prairie Hay shall include all hay not good enough for other grades, and not caked.

No Grade Prairie Hay shall include all hay not good enough for other grades.

No. 1 Straight Rye Straw shall be in large bales, clean, bright, long Rye Straw, pressed in bundles, sound, and well baled.

No. 2 Straight Rye Straw shall be in large bales, long Rye Straw, pressed in bundles, sound and well baled, not good enough for No. 1.

Tangled Rye Straw shall be reasonably clean Rye Straw, good color, sound, and well baled.

Wheat Straw shall be reasonably clean Wheat Straw, sound, and well baled.

Oat Straw shall be reasonably clean Oat Straw, sound, and well baled.

Examining Hay or Straw. With a sharp hay knife cut the bale or pile of hay or straw in two. Then cut off a section about five inches thick. Carefully save the section removed, and separate into its various parts, as Timothy, Clover, weeds, etc. Determine the amount of each by weight.

FIG. 26. A student identifying clover seed

IDENTIFICATION OF CLOVER AND GRASS SEEDS

There is no work which requires more careful attention or is more valuable than the identification of grass and clover seeds, and separating them from their adulterants.

FIG. 27. Tripod lens used in identifying seeds

For examining the seeds a small tripod lens is very useful. Use the following artificial key, which is not intended to describe the seed but simply calls attention to the most prominent characteristics of each variety. It is much better to first learn to identify by use of the key than by use of the drawings.

Key for Identification of Clover Seeds

Seed free (not inclosed in pod)

Seed bean-shaped

Color, pinkish, $\frac{1}{8}$ in. long.....Crimson Clover

Color, mostly yellow; large seeds are kidney shaped.. Alfalfa

(Turkestan alfalfa is same, but slate colored.)

Seeds larger and more regular than in alfalfaBurr Clover

Color, dark yellow to brown Yellow Trefoil

Seed oval-oblong

Color, yellow; seed notched near one end Bokhara Clover

Seed heart-shaped

Color, yellow to brown.....White Clover

Color, dark green to blackAlsike Clover

Seed somewhat triangular

Color, yellow to brownish.....Red Clover

Seed inclosed in pod

Pod large and corrugated, $\frac{1}{4}$ in. long

Color, brown; seed, bean-shaped.....Sainfoin

Pod whitish, $\frac{1}{8}$ in. long

Color, yellow; seed oval, notched near end

Yellow Sweet Clover

Pod brown, $\frac{1}{8}$ in. long

Color, dark brown, seed mottled.....Japan Clover

Key for Identification of Grass Seeds

Seeds distinctly awned

Seed $\frac{1}{4}$ in. or more in length

Very hairy or pubescent, flat, thin.....Meadow Foxtail

Awns attached at tip.....Annual Rye Grass

Awns long, twisted, attached near base

Tall Meadow Oat Grass

Seeds less than $\frac{1}{4}$ in. long

Small brownish seed.....Sheep Fescue

FIG. 28. Crimson clover: *A*, magnified seeds; *C*, natural size

FIG. 29. Alfalfa: *A*, magnified seeds, (*d*) short type, (*e*) long, curved type; *B*, magnified seed pod; *C*, natural size

FIG. 30. Yellow trefoil: *A*, magnified seeds; *B*, magnified seed pod; *C*, natural size

FIG. 31. White clover: *A*, magnified seeds; *C*, natural size

FIG. 32. Bokhara clover: *A*, magnified seeds; *B*, magnified seed pod; *C*, natural size

FIG. 33. Alsike clover: *A*, magnified seeds; *C*, natural size

FIG. 34. Red clover: *A*, magnified seeds; *B*, magnified seed pod; *C*, natural size

FIG. 35. Sainfoin: *A*, magnified seed; *B*, magnified seed pod; *C*, natural size

FIG. 36. Sweet clover: *A*, magnified seeds; *B*, magnified seed pod; *C*, natural size

FIG. 37. Japan clover: *A*, magnified seeds; *B*, magnified seed pod; *C*, natural size

Short-awned or awn-pointed

Small, dark brown seeds, very rough near tip

Crested Dog's-Tail

$\frac{3}{8}$ in. long, smooth, light colored.....Wheat Grass

$\frac{1}{4}$ in. or less in lengthOrchard Grass

Awnless

$\frac{3}{4}$ in. long or thereabout, nerves very prominent....Brome Grass

About $\frac{1}{4}$ in. long { Note difference in shape } Perennial Rye Grass
light brown ... { and size of rachilla }Meadow Fescue

Hard, smooth seeds, about $\frac{1}{4}$ in. long

Dark brown colorJohnson Grass

$\frac{1}{2}$ in. long or less

Keel rough, sawlike.....Redtop

Keel not commonly rough Kentucky Blue Grass

Seed free from glumes, polished

Very small, $\frac{1}{32}$ in. in length, polished Timothy

Key for Identification of Millet Seeds

Seeds ovoid, flattened on one side, and inclosed in glumes, usually shiny, from $\frac{1}{10}$ to $\frac{1}{6}$ in. in length

Seed red or pink.....Siberian Millet

Seed yellowGerman Millet

Seed mostly blackHungarian Grass

Seed dull brown, outer covering loose and rough

Japanese Barnyard Millet

Seed brownish yellow (varieties of this millet are white

and others red)Broomecorn Millet

FIG. 38. Millet seeds: (a) Japanese Millet (*Panicum crus-galli*); (b) German millet (*Chætochloa italica*); (c) Siberian millet (*Chætochloa italica*); (d) Hungarian millet (*Chætochloa italica*); (e) Broomecorn millet (*Panicum miliaceum*)

FIG. 39. Meadow foxtail : *A*, magnified seeds ; *B*, natural size

FIG. 40. Annual rye grass : *A*, magnified seeds ; *B*, natural size

FIG. 41. Tall meadow oat grass : *A*, magnified seeds ; *B*, natural size

FIG. 42. Sheep fescue : *A*, magnified seeds ; *B*, natural size

FIG. 43. Crested dog's-tail: *A*, magnified seeds; *B*, natural size

FIG. 45. Orchard grass: *A*, magnified seeds; *B*, natural size

FIG. 44. Wheat grass: *A*, magnified seeds; *B*, natural size

FIG. 46. Brome grass: *A*, magnified seeds; *B*, natural size

FIG. 47. Perennial rye grass: *A*, magnified seeds; *B*, natural size

FIG. 48. Meadow fescue: *A*, magnified seeds; *B*, natural size

FIG. 49. Johnston grass: *A*, magnified seeds; *B*, natural size

FIG. 50. Redtop: *A*, magnified seeds; *B*, natural size

FIG. 51. Kentucky blue grass: *A*, magnified seeds; *B*, natural size

FIG. 52. Timothy: *A*, magnified seeds; *B*, natural size

SEED TESTING

APPARATUS FOR GERMINATING SEEDS

Germination tests are easily made, even with the simplest apparatus.

A seed incubator is generally made on the plan of an oven, double walled, and often covered with asbestos. The space between the double walls may be filled with water. This is usually heated with a gas jet or lamp so arranged that a fairly constant temperature can be maintained.

The seeds are placed in trays, between or upon moist blotting papers, and kept in the incubator, which is closed up in order to produce a moist atmosphere until germination is complete. The best temperature for germinating most cereal seeds is between 80° and 90° F., but grass seeds should not be heated above 70°, and the temperature should daily be reduced to 50°.

HOMEMADE GERMINATORS

One of the simplest and most practical germinators can be made by taking two common dinner plates and placing in the bottom of one of them two or three layers of filter paper or other absorbent and thoroughly wetting it. Place the seeds to be tested on top of this. If the seeds are large, as corn or wheat, you may cover them with blotting paper or a cloth, though this is not necessary. Small seeds, such as clover or grass, do better if not covered.

Now invert the second plate over the first, being careful to have the edges touch evenly. This makes a moist chamber, and gives the most favorable conditions for germination.

Similar moist chambers may be fixed up by using any shallow bucket or pan having a cover, or tin or wooden

FIG. 53. A corn germinator. The six grains in each square are taken from a different ear. (*Iowa Bulletin No. 77*)

boxes may be used, such as tobacco and cigar boxes, all of which when used properly will give satisfactory results.

The accompanying photograph (Fig. 53) illustrates a very handy device for testing individual ears of seed corn. It is made about two inches deep, and any convenient size. Place in the bottom some absorbent material to hold the moisture, — an inch of sawdust or sand, or a few layers of cloth or

blotting paper. Whatever is used, the top should be covered with a piece of white blotting paper or cloth. Mark this off into two-inch squares or larger, or cover with a piece of wire netting. After the corn grains are placed on the cloth they should be covered with cloth, or the box covered with a close-fitting cover.

A STUDY OF THE GERMINATION OF SEEDS

(Prepared by A. T. Wiancko, Purdue University)

Use seeds and boxes provided. Place a piece of blotting paper in the bottom of each box and have a second piece to cover the seeds. Saturate both pieces of blotting paper. Count 25 kernels each of corn and wheat and place in one of the boxes. Count out the same number each of clover and beans, and place in the second box. Cover these seeds with the second piece of blotting paper. Put on the lid and set aside. Examine every day to note progress of germination and condition of moisture.

1. What is the first act in the process of germination?
2. Which appears first, the radicle (root) or the plumule (leaves)?
3. How many days are required for germination?
4. Is there any difference in the manner in which the cotyledon (seed) is disposed after germination? Explain.
5. Two modes of root development: *axial*, the radicle extending into a taproot with more or less branches; *diffuse*, no evidence of taproot, but numerous long, slender roots. Which of these seeds show such development? Does this teach anything with regard to soil preparation?
6. Look for the rootcap. What seems to be its office?

7. Observe the root hairs. What do you conclude their function to be? Do they teach anything about soil preparation?

8. Make drawings illustrating different stages of development and showing the various points mentioned above.

9. If possible try the germination under cooler temperature and note results.

DETERMINING THE PURE AND GERMINABLE SEEDS IN A SAMPLE OF CLOVER SEED

(Prepared by A. T. Wiancko, Purdue University)

The metal capsule furnished has one gram of seed in it. Separate this sample into four parts: (1) pure seed that from appearance you judge would grow; (2) pure seed that from appearance you judge would not grow; (3) weed seeds; (4) sticks, chaff, dirt, etc.

Count the seeds in each division. Find what per cent each is of the total number. A pound contains 454.5 grams. Calculate the number of each kind of seeds in a bushel.

Put the seeds in each of the above divisions into a moist chamber and give them the germination test. Calculate the per cent of each division that germinates. How does it compare with the mechanical separation? Calculate what per cent the seeds germinating in classes (1) and (2) are of the total number of seeds. If this seed sells in the market for \$8.00 per bushel, what is the actual price per bushel for pure and germinable seed?

A written report is requested one week from the close of the experiment.

SUGGESTED FORM FOR REPORT

SAMPLE NUMBER	PURE SEED (Good Appearance, Number)	GERMINATION (per cent)	NUMBER PER BUSHEL	PURE SEED (Poor Appearance, Number)	GERMINATION (per cent)	NUMBER PER BUSHEL	WEED SEEDS (per cent)	STICKS, DIRT, ETC. (per cent)	TOTAL WEIGHT THAT WILL GROW (per cent)	ACTUAL COST OF THIS SEED PER BUSHEL
1										
2										
3										

Name Date.....

DETERMINATION OF WEIGHT PER BUSHEL

Grain testers are usually made in three sizes — pint, quart, and two-quart. When the measure is properly filled with grain and hung on the balance, the number of pounds the grain will weigh per bushel can be directly read.

The greatest care must be exercised in filling the measure. The grain should not be shaken or pressed down, but should be allowed to fall as loosely as possible into the tester. Do not dip the grain up with the measure, but take the measure in both hands and force it bottom down until the top is level with the grain; then scoop the grain in with the hands, allowing it to fall as loosely as possible. Then, being careful not to press or shake down the grain, stroke the top with a straight-edge and hang on the balance.

A little practice will enable one to do fairly accurate work with the tester.

PRACTICE WORK WITH TESTER

Try taking duplicate samples until you can get the same results every time.

Fill the sampler in various ways, such as dipping it into the grain, or shaking and pressing the grain down a little after the tester is filled, and compare weights with those obtained when tester is properly filled.

TEST FOR MOISTURE IN GRAIN

Use samples of corn of various grades, kept under different conditions, such as corn too wet to grade, corn kept in open crib since husking, corn kept in dry seed room, etc. Also use samples of oats, wheat, and barley.

Sampling. After mixing up your sample carefully, take about two ounces and grind in a fine coffee mill, running it through several times, reducing as fine as possible. Then take a 1-gram sample and dry in a water oven to constant weight. The per cent of moisture is found by dividing by weight of original sample the difference between weight of original sample and dry sample.

LEGAL WEIGHTS PER BUSHEL OF SEEDS¹

State or Territory	Barley	Beans	Blue Grass	Broom Corn	Buckwheat	Castor Beans	Clover	Corn in Ear	Corn in Ear, Unshucked	Corn, Shelled	Cotton, Sea- island	Cotton, Upland	Cowpeas	English Blue Grass	Flax	Hemp
Alabama	47	a60						70	75	56		32				
Arizona	45	a60								54						
Arkansas	48	b60	14	48	52		60	70	74	56		33½			56	
California	50				40					52						
Colorado	48	a60	14		52		60	70		56						44
Connecticut	48	a60			48		60			56	44	30			55	
Delaware										56						
Florida	48	a60				48			70	56	46	32				
Georgia	47	b60	14		52		60	70		56		30			56	44
Idaho	48				42		60			56					56	
Illinois	48	b60	14		52	46	60	70		56					56	44
Indiana	48	a60	14		50	46	60	70		56					44	
Iowa	48	a60	14	30	52	46	60	70		56					56	44
Kansas	48	a60	14		50	46	60	70		56				22	56	44
Kentucky	47	b60	14		56	45	60	d70		56				14	56	44
Louisiana	32									56						
Maine	48	62			48					56						
Maryland																
Massachusetts	48	60			48		60			56	44	30			55	
Michigan	48	60	14		48	46	60	70		56					56	44
Minnesota	48	60	14	57	50		60	70		56					50	
Mississippi	48	b60	14		48	46	60	72		56		32			56	44
Missouri	48	60	14		52	46	60	70		56		33			56	44
Montana	48	a60	14		52	60	70			56					56	44
Nebraska	48	b60	14		52	46	60	70		56					56	44
New Hampshire		62								56						
New Jersey	48	60			50		64			56					55	
New York	48	60			48		60			56	44	30			55	
North Carolina	48				50		60			56		30			55	
North Dakota	48	a60		30	42		60	70		56					56	
Ohio	48	a60			50		60	68		56					56	44
Oklahoma	48	60		30	42		60	70		56					56	
Oregon	46				42		60			56						
Pennsylvania	47				48		60			56						
Rhode Island	48	a60			48	46	60	70		56	44	30			56	44
South Carolina											42	30				
South Dakota	48	a60		30	42		60	70		56					56	
Tennessee	48	a60	14	42	50	46	60	70	74	56		28			56	44
Texas	48	b60			42		60	70	72	56		32			56	44
Vermont	48	62			48		60			56						
Virginia	48	b60	14		52		60	70		56		32	60		56	44
Washington	48				42		60			56					56	
West Virginia	48	a60			52		60			56					56	
Wisconsin	48	a60			50		60			56	44	30			56	44

a Small white beans 60 pounds, other beans 55.

b White beans.

c From harvest to December 1, 70 pounds; after December 1, 68 pounds.

d From November 1 to May 1, 70 pounds; from May 1 to November 1, 68 pounds.

¹ *Experiment Station Work*, Vol. II, No. 15. Compiled from Bulletin 51, United States Department of Agriculture, Bureau of Plant Industry.

LEGAL WEIGHTS PER BUSHEL OF SEEDS (*Continued*)

State or Territory	Hard's Grass	Hungarian Grass	Italian Rye Grass	Millet	Oats	Orchard Grass	Osage Orange	Peanuts	Peas	Rape	Redtop	Rice, Rough	Rye	Sorghum	Soy Beans	Timothy	Velvet Beans, in Hull	Wheat
Alabama					32				60				56					60
Arizona					32								56					60
Arkansas				50	32	14			60		14		56	50		60		60
California					32								54					60
Colorado					32								56			45		60
Connecticut	45				32				60		45		56			45		60
Delaware																		60
Florida				50	32			22					56	56			78	60
Georgia					32				60		43		56			45		60
Idaho					36								56					60
Illinois					32								56					60
Indiana				50	32	14	33						56			45		60
Iowa		50		50	32		32						56	30		45		60
Kansas		50		50	32								56	56		45		60
Kentucky		50		50	32	14			60				56			45		60
Louisiana					32								32					60
Maine	45				32				60									60
Maryland					26													
Massachusetts	45				32				60		45		56		58	45		60
Michigan		50		50	32	14	33		60		14		56			45		60
Minnesota		48		48	32	14			60		50	14	56			45		60
Mississippi		50		50	32				60				56	57		45		60
Missouri		48		50	32	14	36		60		14		56	42		45		60
Montana		50			32				60				56			45		60
Nebraska		50		50	32		32		60				56	30		45		60
New Hampshire					32				60				56					60
New Jersey					30				60				56					60
New York	45				32				60			45	56			45		60
North Carolina					32				60			44	56					60
North Dakota				50	32				60				56			42		60
Ohio		50		50	32				60				56			45		60
Oklahoma					32				60				56			42		60
Oregon					32								56					60
Pennsylvania					32								56					60
Rhode Island		50		50	32				60				56			45		60
South Carolina																		
South Dakota					32				60				56			42		60
Tennessee		48	20	50	32	14	33	23	60		14		56	50		45		60
Texas		48		50	32								56			45		60
Vermont	45				32				60				56			45		60
Virginia		48		50	30	14	34	22			12		56			45		60
Washington					32								56					60
West Virginia					32								56			45		60
Wisconsin		48		50	32				60	50		45	56			45		60

Weights of miscellaneous seeds not included in the table: Amber cane, New Jersey, 57 pounds per bushel; beggar weed, Florida, 62 pounds; canary seed, Tennessee, 60 pounds; hickory nuts, Tennessee, 50 pounds; Indian wheat, Vermont, 46 pounds; Japanese barnyard millet, Massachusetts, 35 pounds; Johnson grass, Arkansas, 28 pounds; Kafir corn, Kansas, 56 pounds; pop corn in ear, Indiana, 70 pounds; Ohio, 42 pounds; Tennessee, 70 pounds; pop corn, shelled, Kansas, 56 pounds; spelt, North Dakota, 48 pounds; velvet grass, Tennessee, 7 pounds; walnuts, Tennessee, 50 pounds.

TEXT-BOOKS ON SCIENCE

FOR HIGHER SCHOOLS AND COLLEGES

	<i>List price</i>	<i>Mailing price</i>
Bergen and Davis's Principles of Botany	\$1.50	\$1.65
Bergen's Elements of Botany. (Revised Edition)	1.30	1.45
Bergen's Foundations of Botany	1.50	1.70
Blaisdell's Life and Health	.90	1.00
Blaisdell's Practical Physiology	1.10	1.20
Brown's Physiology for the Laboratory	.75	.85
Byrd's Laboratory Manual in Astronomy	1.25	1.35
Davis's Elementary Meteorology	2.50	2.70
Davis's Elementary Physical Geography	1.25	1.40
Davis's Physical Geography	1.25	1.40
Gage's Elements of Physics. (Revised Edition)	1.12	1.20
Hastings and Beach's General Physics	2.75	2.95
Higgins's Lessons in Physics	.90	1.00
Hough and Sedgwick's Human Mechanism	2.50	2.65
Linville and Kelly's Zoölogy	1.50	1.70
Meier's Herbarium and Plant Description. With direc- tions for collecting, pressing, and mounting specimens	.60	.70
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